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A SYLLABUS

OF THE

LECTURES ON HYGIENE

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BY

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LECTURE I.

A physician's highest aim and duty should be to prevent disease rather than to cure it. He must do all he can to advance Preventive Medicine, in order to maintain the good name of the Profession. Nor will this militate against his own interests, for health means ability to work and earn wages, and in the majority of cases the doctor will be better recompensed in a healthy community than in an unhealthy one. Note the close relation existing all the way thro' between Preventive Medicine and Social and Political Economy.

To be successful a physician must know thoroughly three things: I. Health and its laws; how to obtain and preserve it. This implies a knowledge of Anatomy, Physiology and Chemistry: 2. Disease; its causes and nature. Disease is an entity and must be combatted with matter and force; 3. Therapeutic Agents, both preventive and curative. The workman must know his tools, and one cannot fight disease with mere theories.

What is Hygiene? The Art and Science that considers the Preservation and Promotion of Health and the Prevention of Disease. Health is perishable as well as attainable; but much can be done in the way of preventing disease. From one-seventh to one-fourth of all the deaths of the world are said to be due to Tuberculosis. How many of these could be prevented or postponed and how much illness and misery avoided by a proper attention to sanitation and hygienic laws?

Hygiene considers:-I. The Preservation and promotion of Health;
2. Practical Disinfection, and the means of avoiding preventible diseases;
3. Adaptation of Diet to the cure of perversions of nutrition.

Under one or the other of the above will come the consideration of I. The Air we breathe; 2. The Water we drink, and 3. The Soils and Surroundings of our communities; and at the same time the study of the means of recognizing, avoiding, correcting or removing Impurities affecting any of these: 4. The recognition of Adulterations or Deteriorations in Food; 5. The dangers of the abuse of Stimulantsor Narcotics; 6. The desirability of Chaste living; 7. Clothing and Shelter.

The scope of this Science is too vast for one to go thoroughly over the entire ground in the time allotted, but, as it is the duty of the physician especially to know how to recognize and remove insanitary conditions wherever found, I will try to give the fundamental laws of Hygiene as we now understand them, especially those most closely connected with a conscientious physician's duties and practice. Consequently, the scheme of the course will be somewhat as follows: The influence of Heredity as predisposing to the resistance to or acquiring of certain diseases or diatheses; The Air; its constituents and impurities; amount necessary for health; the moisture in air and its effect on health; Soil Air; Ventilation, natural and artificial, including the heating of dwellings; etc., etc.; Potable Water; its sources, purity or impurities; diseases produced or ~~aggravate~~ ated by the use of impure water; the filtration, preservation and chemical treatment of water; Chemical Analysis; Disposal of Sewage; Plumbing; traps, drains, etc.; Dietetics; Clothing; Bathing; The relationship of Microorganisms to disease, and place of Bacteriology in Hygiene; Ptomaines and Leucomaines, and how they affect health; etc.

It is an ART to preserve health, though the SCIENCE tells how to do so. Common sense must be freely used in the study of Hygiene.

Hippocrates gave the following as summing up the knowledge of his day in Hygiene: Air,Aliment,Exercise and Rest,Sleep and Wakefulness,Repletion and Evacuation,and the Passions and Affections of the Mind.

Parkes says; "Taking the word 'Hygiene' in its largest sense,it signifies rules for the perfect culture of mind and body. It is impossible to dissociate the two. The body is affected by every mental or moral action;the mind is profoundly influenced by bodily conditions: for a perfect system of hygiene we must train the body,the intellect and the moral faculties in a perfect and balanced order." "The human being must be considered: Ist.,In relation to the natural conditions which surround him; 2nd.,In his social and corporate relations,as a member of a community,subject to social and political influences; 3d.,In his capacity as an independent being,having within himself sources of action,in thoughts,feelings,desires,personal habits,all of which affect health,and which require self-regulation and control." "Such a work would,if followed, almost change the face of the world."

Hygiene is not yet an exact science. It is on a firmer basis in Europe than in America,but it has gained a footing here and is rapidly attracting popular notice and attention. Many of its facts and laws are yet to be discovered,and these are to be looked for especially in the domain of Bacteriology,in the Prevention of disease and in the chemistry of Animal Alkaloids.

HYGIENE of STUDENT LIFE. To do work with the greatest efficiency and to obtain the best results therefrom it is important to keep in the best mental and physical condition,to have "mens sana in sano corpore." Hints to this end are suggested as follows:--

Make a systematic division of the day;have something for each particular hour. Rest by changing work from one subject to another. Give at least two hours for meals and eight for sleeping.Make sure of getting as good and wholesome food as possible:efficient and satisfactory work requires a sufficient supply of good food to supply the necessary amount of force,nervous,mental and physical. However,keep the diet simple and light and avoid whatever you know does not agree with you. Be temperate and continent. Have the work room properly heated,but not too warm;the sleeping-room cool. Rest often for a few seconds or moments at a time. Learn to relax and to put all thoughts of your work out of your mind at the time set apart for rest and recreation. To take a short nap of five or ten minutes in the middle of the day or before beginning night work is often beneficial. The habit or faculty of sleeping or awakening at will is a valuable one,especially for a physician. Keep body and clothing clean that the skin may be in the best possible condition and the work of the kidneys be lessened. A cool sponge bath in the morning is often beneficial,not only for its cleansing,but also for its tonic effects;at night it may help to promote good rest and sleep. Be regular as to the time for evacuating the bowels,as well as to the hours for meals and sleep. Keep in a sort of half-training,as it were. Take time for proper physical exercise,and take it regularly and in the open air,if possible. Have a walk out of doors at least once a day. Have a thorough physical examination made before taking up any severe special exercise. Rest completely on Sunday from all routine work,not only on moral grounds,but because the work will then be less likely to become monotonous and distasteful, and because more will be accomplished in the end.

EXERCISE. Is generally considered to mean simply the action of the Voluntary Muscles. But Exercise has a wider meaning. Every organ in the body is capable of being exercised, and if not properly exercised an abnormal state will ensue. Deficiency in exercise favors a lack of nutrition, wasting in size and eventually degeneration of tissue: too much exercise favors hypertrophy and even tissue degeneration. Every organ has its own especial stimulus; if this be normal in amount and character, we have health. The trained use of an organ makes it more effective for its purpose. Must give some thought to the other organs besides the muscles, but shall devote most time to the consideration of muscular action.

Proper muscular exercise is highly beneficial and in the end actually necessary to the proper performance of function in other organs. Physical exercise is consistent with and necessary to health. "Life is Organization in Action."

Proper exercise makes muscles harder, larger and they respond more quickly to the will. Over-exercise, too prolonged exertion or lack of sufficient rest interferes with nutrition, and causes wasting, softening and loss of force. During muscular action, (contraction,) there is a conversion of potential energy into motion, a call for more food, an increased demand and consumption of oxygen and an increased production and elimination of carbon dioxide and waste matters. This increased demand for O and elimination of $CO_2$ necessitates increased action of the respiratory organs, the lungs.

In this fact lies the greatest advantage of physical exercise. The respiration is increased in frequency and depth, the lungs expanded, the air vesicles flushed out and refilled with each inspiration and expiration. Doubtless many cases of pulmonary tuberculosis or consumption could be prevented or cured if only people could be taught to breathe properly and take proper exercise. Rarely find the lungs fully expanded except in the out of door worker or athlete.

Conversely, if any severe exercise is to be undertaken or a course of training begun, especial care must be had to increase the lung capacity. A man walking at the rate of four miles per hour inspires five times as much air as when reclining at rest. The average amount of air inspired at rest is, for an adult, 480 cu.in.per minute. Or, as Pettenkofer shows, a man on a day of rest absorbs 25 oz. of O and throws off 32 oz. $CO_2$ and 29 oz. water; on a day of work he absorbs 33.6 oz. O and throws off 45 oz. $CO_2$ and 72 oz. $H_2O$. In other words, the elimination of pure carbon on a work-day is more than three-fourths of a pound.

Muscular exercise is necessary, then, for the proper elimination of waste carbon from the body, and if exercise be neglected the carbon in the food; i.e., the starches and fats, must be lessened, or the C will accumulate in the system. Moreover, as much $CO_2$ is produced in the muscles, and as their action is checked or lessened if it is not carried off by the blood and eliminated by the lungs, it follows that during exercise there should be nothing to impede the action of the chest and lungs or the circulation. Consequently, all tightness of clothing should be avoided, especially about the chest.

After exercise an increased amount of carbonaceous food and of water must be supplied to replenish the system for what has been eliminated. The increase of carbon is best given in the form of fat rather than the carbohydrates, and of all fluids, water is probably in ordinary cases the best to use in training. Alcohol is harmful.

because it lessens the excretion of $CO_2$ from the lungs and because it benumbs or deadens the nerves and will, and as every voluntary impulse must originate in the brain, anything that interferes with the communication between it and the muscles must lessen the promptness with which they respond and the consequent efficacy of their work. The use of a small amount of malt liquor or wine may not be harmful, but the decision should be left with the trainer or some one else than the person who is to use it.

Inasmuch as the amount of $CO_2$ and other waste matters thrown off during exercise is so very much increased, a much larger amount of pure air is necessary and all enclosed rooms and buildings wherein exercise is to be taken must be well ventilated.

By exercise the action of the heart is increased in force and frequency, the pulse is full and strong if the work be not too excessive or sudden, and the flow of blood and other fluids is increased throughout the whole body. As long as the heart is not overtaxed the pulse beats are regular and even, though suddenly increased exertion may make the rate very rapid. Ordinary exercise increases the rate from 10 to 30 beats per minute. Excessive exercise leads to palpitation and hypertrophy of the heart, (one reason why any training should be under a competent trainer,) but on the other hand deficient exercise leads to a weakening of the heart-action, and probably to dilatation and fatty degeneration. If at the beginning of a new exercise the heart-action becomes irregular, rest should be taken and the exercise then begun in a more gradual way.

Exercise greatly increases the amount of perspiration from the skin. This perspiration contains water, salt and considerable waste matter. The evaporation of the water tends to keep the body cool, but there is not much danger of chilling the body during exercise on account of the great heat production. As soon as work is stopped heat production is checked, the body cools off rapidly and there is danger of chilling unless more clothing be added. Flannel is best for this, because it is a non-conductor of heat and prevents too rapid cooling of the body. Keep the skin clean so that the sweat glands may be unobstructed in the performance of their functions.

Exercise increases the appetite, partly because of the increased demand of the muscles for food, and partly on account of the increased circulation of the blood through the liver and vessels of the alimentary tract, this causing a more perfect digestion of food.

Proper physical exercise favors a symmetrical brain development, as exercise of the functions of the centers governing the action of the muscles must favor the growth and development of those centers. "Hand culture, apart from its value per se, is a means toward more perfect brain culture."

The aim of training should be to increase the capacity of the lungs and the breathing power, to make the muscles more powerful, more responsive to the will and their capacity for endurance greater, and to lessen the amount of fat. Systematic exercise helps one to resist disease, because by it waste matters are carried off, pores glands and organs are kept active, and healthy and active tissues take the place of weak and sluggish ones.

Fatigue is due to lack of contractile material in the muscles to continue work, to the exhaustion of nerve force and motor impulses from the brain, and to accumulation of waste products in the muscle.

Active exercise is that brought about by one's own movements; Passive, that produced by something outside of or collateral to one's power.

If exercise be taken too soon before meals,either the stomach by calling the blood from the exhausted muscles will prevent their proper repair and rest,or the muscles calling the blood from the stomach will prevent the proper formation of the gastric juice when food is introduced. If exercise be taken too soon after eating,it is apt to prevent the flow of blood to the stomach and formation of gastric juice,or by forcing the contents of the stomach into the intestines before gastric digestion is completed,and before the food has reached a condition in which the intesines can make use of it, to cause intestinal irritation and indigestion.

It is hard to determine how much exercise any given person ought to take,as the personal equation varies so. The average healthy man ought to take the equivalent of I50 foot-tons daily. The work of walking on a level at the rate of 3 miles per hr.is said tobe equal to that of raising I/20 of the body-weight through the distance walked. According to this,a man of I50 lbs. in walking one mile does work equal to I7.67 foot-tons,and he would have to do work equivalent to walking 9 miles at the above rate to get the proper amount of daily exercise.

HEREDITY. The transmission to offspring from parent or ancester of a trait,type,temperament or characteristic or predisposition which has a governing or influencing effect upon the growth or nature of that offspring. The transmitted impression may be either for good or evil. As Sanitarians we must do all we can to have only beneficial or elevating characteristics transmitted and those of harmful tendency checked or blotted out. Easier to maintain health in this,as in other ways than it is to restore it. A man with a good constitution resists disease better than one without,and to produce healthy children not prone to disease both parents must have good constitutions and should take great care not to weaken them by excesses of any kind,nor,as far as possible,by any chronic disease. No great nation has ever been destroyed until its people first neglected the laws of Hygiene,Heredity and Sociology.

We must use all our influence to blot out and prevent the transmission of harmful influences and hereditary diseases to the coming generations. The Family is the foundation of the State. The basis of the F amily is man's instinctive desire to protect his wife and offspring. Society is but a congregation of men for the purpose of acquiring more power and comforts through cooperation. Society then has the right to make men understand that they must care for the health of future generations:the State to enact just laws looking to the prevention of transmission of infirmities.

Children of parents that have been conscientious followers of Nature's laws haye a better chance for health all through their lives.

Distinguishing characteristics are more apt to be transmitted in the early married life of parents,because their organs and vital forces are then more vigorous. But if a couple marry young and before their own organs are fully developed,their elder children are more apt to be deficient than the younger ones. In this climate the proper age for marriage is considered to be about 24 or 25 for men,and I9 or 20 for women,though this must vary with the state of development of the parties concerned. Usually before the ages given development is not completed in this climate and the whole organism is in a transition state. The use of any organ before it has attained complete development is apt to cause exhaustion or even degeneration of that organ,and children developed in immature sexual

organs must be deficient in true vital force and energy. Late marriages are not likely to be as fruitful as earlier ones, possibly owing to the increased difficulty in parturition; but healthy middle aged persons may have healthier children than those who have married too early or have worn themselves out by excesses.

In features, constitution, sense organs and shape of head the child is most apt to resemble the father; in the shape of the body and the formation of internal organs, the mother. The character and mental qualities may come from either parent or both.

Marriage favors longevity in the male, and possibly almost as much so in the female, in these days of antiseptic midwifery.

Hereditary influences are generally transmitted directly from parent to child, but occasionally we find a cessation of a characteristic or predisposition for one or more generations and then a recurrence. To this peculiarity we give the term--Atavism.

The most important hereditary or transmissible diseases are:- Syphilis, Consumption, Scrofula, Cancer, Gout, certain skin diseases, insanity, various criminal tendencies, Epilepsy, Hysteria, etc. What may appear to be an inherited disease may not be so, but the disease may have been produced by the same environments or morbid causes that produced or favored the disease in the parent. Even here there may have been a transmitted predisposition to the acquiring of the disease.

A disease may be truly congenital, transmitted directly from parent to child; or there may be only a hereditary predisposition to it, making the child more susceptible to exciting causes. The physician must guard against the transmission of such diseases, and must combat any symptoms of them as soon as discovered in the child. Must put the child at once under the most favorable hygienic surroundings. In many cases early interference will accomplish much good, and the disease may be entirely averted. This is especially true of the tuberculous predisposition. Can also do much by preventing production on the part of those unfit to bear offspring, and by fighting causes and their effects in the individual, especially at the age or time when these have the greatest force.

Dr. Billings says; "1. No marriage should occur between persons having the same hereditary tendency to disease; and this is especially important in marriages between relatives. 2. A girl should not marry in this climate under the age of twenty. 3. A person affected with hereditary or well-marked constitutional syphilis, or having a strong consumptive taint, or tendency to mental unsoundness, should not marry at all."

Infirmities which do not tend to the degeneration of offspring are not good reasons alone for forbidding marriage. A man should not marry a woman advanced in life, nor one feeble, very delicate or deformed, especially as regards the chest or pelvis. Hysteria, convulsions and epilepsy due to organic disease should prevent a woman from marrying, though some women very nervous and even hysterical are much benefitted by marriage and have healthy children.

The eyes of children whose parents have defective eyesight should be examined before putting them in school or at any work requiring continued use of the eyes and glasses furnished if necessary.

Marriage between relatives is reprehensible, the danger increasing with the nearness of relationship. The strong or advantageous characteristics do not seem to be transmitted with the same readiness as are the faults or weaknesses.

# LECTURE III.

AIR. One of the most important results of physical exercise is the increase in depth and frequency of respiration. Normal respiration is dependent upon four conditions: 1. Healthy lungs; 2. Sufficient power in muscles of respiration; 3. Sufficient nerve force and healthy nerves to transmit impulses to the respiratory muscles; 4. PURE AIR. Will consider this last requisite for the present.

The composition of the atmosphere throughout the Earth is remarkably uniform. Is practically always the same everywhere, provided no obstacle be interposed to the action of those natural forces by which this uniformity is maintained. The atmosphere is practically about forty miles in depth, and its preesure on the human body is equivalent to about fourteen tons.

The composition of the air in its purest state is about as follow Oxygen,-20.96%, Nitrogen,-79%, Carbon Dioxide,-0.04%, an amount of Aqueous Vapor varying with the temperature, a trace of Ammonia, and a variable amount of Ozone, Organic Matter, Sodium salts, etc.

The mixture is a mechanical, not a chemical one, and there are always some slight changes taking place in the proportion of the above constituents. The mixture is maintained in its uniformity by the Diffusion of Gases, the law of which is that "a gas expands into a space in which there is another gas as freely and rapidly as if there were a vacuum." This force is continually operating, but may be facilitated by air currents or the application of heat. When a gas is thus diffused it will not separate under ordinary circumstances.

Oxygen is the most important of the above constituents. It supports all animal life, oxidizes, destroys and renders harmless organic impurities, and by oxidizing the food and oxygenating the blood in the lungs and tissues produces heat and energy, the sources of all our motions. In man the greatest limit of life without air or O is about 3&1/2 minutes. If the supply of O is cut off and the oxygenation of the blood in the lungs prevented, we have checking of the pulmonary circulation and an accumulation of the blood in the veins, then an excitation of the pulmonary nerves, motor impulses from the brain to the respiratory muscles and a struggle by these muscles to introduce air; then an overwhelming of the nerve centers by the carbon- and waste-laden blood, loss of action, insensibility and death. Nitrogen seems to be present to act simply as a diluent and to prevent the too rapid action of the Oxygen.

The Carbon Dioxide present in pure air is of no direct use to animal life, but is essential to the support of vegetable life, furnishing the Carbon that goes to make up the carbohydrates, which is, next to water, the largest constituent of plants. The proportion of $CO_2$ in pure air varies somewhat from time to time, owing to changing conditions. It is washed out of the air by rain and there is less after a heavy storm; plants absorb it by day and give it off at night, the strata of air nearest the ground receive it from the soil air, etc. Though heavier than the air it is evenly distributed thro' it by the force of diffusion. The proportion in pure air varies from .03% to .05%, but we can take the average to be .04%. However, in making any delicate tests always determine the proportion in the out-door air at that particular time. The amount of Aqueous Vapor varies constantly because the factors governing it, condensation and evaporation, are constantly in action. There is probably never a perfectly dry air except artificially; and precipitation occurs at the moment of exceeding complete saturation.

In all normal air there is at least a trace of Ammonia, a small amount of Ozone, some of the salts of Sodium, especially near the ocean, and a trace of Organic Matter. This last is part of the animal and vegetable debris of the Earth: when it rises above a trace it is to be treated as an impurity.

The impurities to be found in air and that have a deleterious influence upon health are I. Suspended substances; 2. Gaseous substances; or 3. Those produced by respiration, combustion, decomposition, etc. Minute particles of almost every substance known are constantly being thrown off into the air; and it is only the constant action of Nature's purifying powers that keeps the proportion within the limits of safety for the human race. Solid particles, lifted up by the winds, fall to the earth again or, if organic, are oxidized and decomposed by the O and ozone. The gases are diluted and diffused so as to be no longer harmful, or are decomposed, or are washed back to the earth by the rain and snow. The great excess of $CO_2$ is kept within bounds by the action of the vegetable world. The most important suspended matters are sand and dust, soot, pollen, microorganisms of all kinds, particles of food, clothing, etc. These may do harm by clogging up the air vesicles of the lungs and interfering thus with respiration, by their irritant action upon the respiratory passages, by being in themselves poisonous or hostile to the system, or in the case of microorganisms, by the power they have in the causation of disease. These disease germs may lodge in the respiratory tract to do their harm, or may be swallowed and set up diseases that affect the alimentary tract primarily, as in cases of Typhoid Fever or Cholera. We must make a distinction as to whether these solid impurities are found in out-door air or in enclosed spaces, and if in the latter, whether in healthy dwellings, in sick-rooms or hospitals, or in workshops and factories. Out of doors dust, sand, soot, dirt from dwellings and the remains of plant and animal life will predominate. In-doors the particles will be limited in variety but not in importance. Among them will be epithelium, round and possibly pus cells, hair, particles of clothing, upholstery, furniture, etc. You may also here find arsenical or other poisonous dust from wall-paper or paint. In hospitals you will probably find pus cells, spores and mycelia of skin diseases, bacteria and disease germs. Mills, factories and mines have their special atmospheres filled with particles peculiar to the materials or occupation and which have a marked effect in most cases on the health of the workers.

The gaseous impurities of most importance are $CO_2$, whenever it exceeds .05%, carbon monoxide, sulphur dioxide, sulphuric, hydrochloric and nitric acids, hydrogen sulphide, ammonia and its sulphide, peculiar gases from sewer air and organic vapors from decomposing animal and vegetable matter. It will be best to consider them with the impurities produced by the processes of respiration, combustion, etc.

An adult man gives off from I2 to I4 cu.ft. of $CO_2$ in 24 hrs. when at rest and according to his size; women and children in proportion. Pettenkofer estimates the average man, not doing excessive work, as giving off 0.7 cu.ft. per hour. In addition to this there passes off from the lungs and skin of each person every day from 30 to 40 ounces of water and much organic matter, either in the form of epithelial and other cells, or of organic vapor in combination with water. The average amount of $CO_2$ per person given off in a mixed assemblage is 0.6 cu.ft. per hr. The organic matter oxidizes but slowly, even in a plentiful supply of fresh air, and contains N, as is shown by its yielding $NH_3$ upon combustion. It has a bad odor and is

this organic matter that gives the close or foul smell to rooms that have been occupied for a long time without proper ventilation, and it is in this that the danger of respired air lies, and not in the $CO_2$ given off by the lungs, as many erroneously supposed.

However, although the $CO_2$ is not the harmful element in respired air, it has been found that in healthy persons it maintains almost a fixed ratio to the amount of this poisonous organic matter. and as it is very difficult to estimate the exact amount of this organic matter, while the amount of $CO_2$ can be estimated quickly and with reasonable accuracy, we thus take the $CO_2$ present in the air, in excess of that at the same time present in the external air, as a measure of the organic impurity of the air and as an index of the quality of the air itself. For instance, the odor of organic matter is just noticeable when the total $CO_2$ in the air reaches .06%, and the air is close and almost foul when the $CO_2$ equals .1%. This rule does not hold good, however, when $CO_2$ is being added to the air from other sources than the lungs, nor in the sick-room, for in this latter case the amount of organic matter thrown off by the patient is out of all proportion to the $CO_2$, both as regards quantity and offensiveness.

The more important of the impurities given to the air by combustion are C, $CO_2$, CO, S, $SO_2$, $H_2SO_4$, and $(NH_4)_2S$. In the combustion of coal a small amount of carbon is given off in the form of fine tarry particles, but on account of its weight it is only found in the lower strata of the air. It is always abundant in the air of cities.

The $CO_2$ and $SO_2$ from combustion render the air of towns acid, tho' this acidity may be increased by the presence of chemical works.

The amount of CO and $CO_2$ produced depends upon the perfection of combustion. Partially burned illuminating gas gives about 7% of $CO_2$ and 5% or 6% CO, together with some $SO_2$ and $NH_3$. Water gas gives more CO. In the open air these are rapidly diluted and carried off; but in closed rooms the air is soon rendered impure when large quantities of gas are burned and the health of the occupants is affected if they spend much time therein.

What is commonly called sewer-gas is but a mixture of the above gases together with a large amount of organic matter and the volatile products of animal and vegetable decomposition. It varies much in composition, owing to the condition of the sewer, kind of matter received, amount of surplus water, etc. The air from a closed cesspool may be extremely foul and poisonous; that from a properly constructed sewer may be even freer than the outside air from $CO_2$, tho' the organic matter will be in excess. Bacteria are always present in varying numbers, with always the possibility of some of them being the germs of specific diseases, though fresh sewage is not so likely to contaminate the air as that in which decomposition has commenced. When this air from sewers or cess-pools escapes into the outer air it is rapidly diluted beyond any power for harm, but if it gains access to closed rooms or dwellings without proper ventilation, even though it contain no disease germs, its effect on the health of the inmates is depressing and decidedly bad.

There is no direct evidence that the air from cemeteries, soap factories, bone yards, etc. is really harmful to health, though all such places should be under the control of proper authorities.

The air of mines is apt to be bad from the gases from fissures in the rock and those of blasting agents, and from products of respiration. The air in the holds of ships is apt to be foul owing to the slight opportunity for changing it and the character of the cargo. Care must be had that it does not affect passengers or crew.

~~Diseases~~ caused by impure air. If the human system be exposed for any considerable length of time to conditions of impurity or deterioration in the air, water or food, a marked falling off in the health is the result; and this in spite of the power of Accomodation which it has of accustoming itself by habit to withstand influences which in one unaccustomed to them would soon produce serious results. But impure air will always undermine health and make the body less able to withstand disease, even if it do nothing else.

The diseases caused by the solid impurities in the atmosphere almost all, with the possible exception of the bacteria-produced ones, are such as affect the respiratory organs and passages. Much depends on the physical character of the dust or solid impurities as regards the harm that is done. Soft particles and those with edges smooth and rounded, like soot and coal dust, may do nothing more than clog up the air-vesicles and finer bronchial tubes, and in that way diminish the area of lung-tissue exposed to the inspired air. With most of us this is of little account if pains be taken to develop the full capacity of the chest. But where the air is heavily charged with such dust it has a real effect on the health and duration of life. "The 300000 miners in England break down as a class prematurely from Bronchitis and Pneumonia caused by the atmosphere in which they live. The only exception is among those who work in well-ventilated mines." But of all miners, those mining coal are least subject to Phthisis, though prone to Bronchitis and Pneumonia, while the miners of those metals of which the particles of dust are sharp and angular are most of all subject to Phthisis and the mortality among them from this cause alone is enormous. Among Cornish tin miners 68% are consumptive, while among coal-miners but few cases of true Tuberculosis are to be found. So also in occupations where sharp particles of metal are thrown off into the air. Of file- and needle-makers over 60% of all sick are consumptive, and of flint and glass-cutters and polishers and grindstone-makers from 80% to 90%. A mixture of mineral and metallic dust seems to be more dangerous than metallic dust alone. So with other occupations where there is much irritating dust floating in the air is the mortality high. Among cotton and flax dressers the consumptives number 60% of all sick, and in cotton factories the mortality is high. Workers in poisonous metals, as lead, arsenic, etc., are subject to those poisons and the symptoms produced by them, with a correspondingly increased mortality.

Among the diseases that may be caused by the inhalation or swallowing of specific bacteria (disease germs) floating in the air are Erysipelas, Measles, Scarlet Fever, Diphtheria, Whooping Cough Infectious Pneumonia, Tuberculous Phthisis and probably Epidemic Influenza. So also the germs of Cholera, Typhoid Fever and Yellow Fever may find their way into the system in this manner, though they are usually taken in in the drinking water. The poison of Malaria is also most probably a minute organism, is undoubtedly to be found in the air and may be carried long distances by the winds. Again the pollen of plants is now thought to have much to do with the causation of such diseases as Hay- and Rose-Fever.

An increase of $CO_2$ in the air from other sources than respiration and combustion seems to have no appreciable effect on the system till it reaches about 2%, when in some persons severe headaches are produced. Dr. Angus Smith found that 3% caused slowing of heart action, feebleness of pulse, quickening of respiration, etc., though other observers have not noticed the same symptoms. Parkes says that the gas is fatal when above 5% or 10%, and yet it is stated

stated that air containing 20% of $CO_2$ has been used as an anaesthetic, but here ordinary air must have been inhaled at the same time, thus correspondingly reducing the percentage. Animals can stand a high percentage of $CO_2$, provided the percentage of O be also increased. Have no evidence of cases of chronic poisoning by $CO_2$, though "the presence of a very large aount of $CO_2$ in the air may lessen its elimination from the lungs, and thus retain the gas in the blood and in time possibly produce serious alterations in nutrition." It is probable that the gas will prove fatal in quantities of 10% or more if breathed for any considerable length of time, though this is not definitely proven. In cases of poisoning by this gas there is an almost immediate loss of muscular power; but when a person overcome by it when brought into an atmosphere of pure air recovers rapidly and, in most cases, completely. The case is different in poisoning by CO. Less than one-half per cent has caused poisonous symptoms and more than 1% or 2% is quickly fatal to animals. Recovery from its its effects is slow and uncertain, because the CO unites with the Haemaglobin of the red blood corpuscles, forming a fixed compound and rendering them no longer able to act as oxygen carriers to the tissues; while the union of $CO_2$ is always a loose one easily destroyed as soon as a fresh supply of O is furnished. The symptoms of CO poisoning are feebleness, oppressed breathing, tremblings and inability to swallow. The blood and muscles are made brilliant red by CO, darkened by $CO_2$. Bernard says that a mixture of the two gases is more destructive than either separately.

The symptoms caused by coal gas, a mixture of H, CO, $H_2O$ and carburetted hydrogen, are, when mixed with a large proportion of air, giddiness, headache, nausea with vomiting, confusion of intellect, loss of consciousness, general weakness and depression, partial paralysis, convulsions and the usual symptoms of asphyxia." $SO_2$ and $H_2S$ are fatal to life, the latter when in a concentrated state, but they are irritating and thus give warning of their presence, and so are not apt to cause serious results. Animals are affected by small proportions $H_2S$; men can accustom themselves to larger percentages of it. Continued exposure to it is liable to give rise to vertigo, headaches, slow and weak pulse, sweatings and loss of strength.

The impurities of respired air are $CO_2$, aqueous vapor and organic matter. If these accumulate in air above a certain percentage, all breathing that air will be more or less affected and some will have headaches, heaviness, physical and mental torpor, quickened pulse, loss of appetite and nausea, thirst, etc. If these impurities be concentrated, serious and even fatal results will ensue, as in the case of the Black Hole of Calcutta, the steamer Londonderry, etc. Even if the percentage be not great, if breathed for a long time or habitually, it causes pallor, loss of appetite, decline in strength, interference in the aeration and nutrition of the blood, glandular enlargements and an increase in pulmonary affections. It is the most important predisposing factor in the causation of Phthisis, even though usually re-enforced by lack of exercise, improper food, over-work, improper bodily position, etc. The decrease in mortality from this disease has been wonderful in prisons, factories, barracks, etc. where good ventilation has replaced bad. Have also much reason to believe that Bronchitis and Pneumonia are much favored by a respired air that is impure. Lastly, it is almost certain that such an atmosphere causes a more rapid spread of contagious diseases; the disease germs either accumulating in the air, or it favoring their growth and multiplication, or such air rendering the system less resistant to disease, or all three acting together. This is especially true in sick-rooms.

In sick-rooms the air is liable to become much more offensive than in ordinary rooms and the necessity for good ventilation is therefore greater. Without ventilation diseases will be more severe and convalescence more prolonged.

It is difficult to determine the exact quantity of solid impurities in the air at any given time, but we may readily determine their character and be able to judge as to their influence for evil. To make a qualitative examination for suspended matters, draw the air through a U-tube packed in ice: this will condense the moisture of the air on its interior; which will arrest a large proportion of the solid impurities. The water can then be poured out of the tube, the sediment allowed to settle and then examined under the microscope. To have some idea of the percentage of these solids in the air it is necessary to have some means of measuring the quantity of air drawn through the tube. A better way yet will be to draw the measured quantity of air through a few c.c. ofpure distilled and filtered water, and then to evaporate the water to dryness over a water bath. The dry residue will consist of the solid impurities of the air together with a little organic matter held in solution by the aqueous vapor of the air. The part that remains of this residue after heating it to redness represents the inorganic portion of the suspended matters; that which is lost, the organic portion plus the dissolved organic matter of the aqueous vapor. In measuring air it may be well to remember that 1000 fluid ounces equal 1733 cubic inches, and that this is almost equivalent to one cubic foot or 1728 cubic inches. The slight difference may often be neglected in any rough calculations.

To make a bacteriological examination of the air expose for a short time shallow dishes filled with nutrient gelatine; then cover with sterilized covers and set aside for a day or two. The living organisms falling on the gelatine rapidly multiply and form characteristic colonies which may be examined macroscopically and microscopically from time to time. Of course, the gelatine must be sterilized before making the "exposure." For collecting the dust and bacteria for immediate microscopical examination, especially in public places, the apparatus devised by Dr. Dixon is especially well adapted.

The organic impurity existing as vapor in the air is determined by drawing a given amount of air through distilled and filtered water and then testing as for organic matter in water. But as the $CO_2$ present is usually a good index of the quantity of organic matter, we generally test for the $CO_2$ as being the easier and readier method. One of the best methods is that suggested by Pettenkofer, which consists of shaking a given quantity of lime- or baryta-water in a large jar of known capacity filled with the air to be examined. The degree of alkalinity of the lime- or baryta-water is determined both before and after the experiment by means of a standard oxalic acid solution, the difference in alkalinity denoting the amount of $CO_2$ in the air in the jar and which went to neutralize the alkaline lime- or baryta-water. A quicker method, and one accurate enough for all hygienic purposes is Rosenthal's. It consists in slowly drawing the air through a milli-normal solution of Sodium Carbonate faintly colored with a little Phenol Phthaleine, and then measuring the air thus drawn through. A given quantity of the soda solution requires exactly a certain amount of $CO_2$ to neutralize it and destroy the color; consequently, when the color is destroyed that amount of

$CO_2$ divided by the quantity of air drawn through will give the % of $CO_2$. Another method is to use this same solution of Soda and Phenol Phthaleine, together with a jar of known capacity. We know that each cubic centimeter of the solution requires a certain amount of $CO_2$ to neutralize it. If now we introduce into the jar filled with air this solution, c.c. by c.c. shaking well in the intervals, the quantity of solution used at the moment decolorization occurs will indicate the amount of $CO_2$ in the jar, and that divided by the capacity of the jar gives the % of $CO_2$. The jar should be stoppered with a perforated cork, the perforation just large enough to admit the end of the pipette carrying the solution, and being closed during the agitation by a piece of glass rod.

SOIL AIR. The Soil, in Hygiene, means all that portion of the Earth's crust that can in any way affect health. All soils contain more or less air: soft sandstone from 20% to 40%, loose sands from 40% to 50%, and loose soils many times their actual volume of air. As the soil is the recipient of most of the solid and liquid waste of all active life, both animal and vegetable, the soil air will naturally be far from pure, considered by the standard of the out-door air above. It is usually rich in $CO_2$ and in organic vapors and gases; the presence of $H_2S$, carburetted H, etc. depends on the presence of decomposing animal matter or the composition of the mineral matter of the earth. The proportion of O seems to be always less than that of the air above ground. The composition of the soil-air is not constant for the same place at different times nor for any two places. The soil-air is constantly in circulation, even to a considerable depth, but there is a hindrance to the free circulation and diffusibility of the air above, and this together with the great variation in the distribution of oxidizable matters causes the difference in composition. The $CO_2$ cannot, therefore, be taken as the index of its purity. The forces that maintain the circulation of the ground-air are the wind, the daily change of surface temperature, the fall of rain, and, especially in winter, the local and artificial conditions of civilization. A very slight wind will drive the air through the soil for long distances and to a considerable depth. Owing to evaporation from the ground-water, the soil-air is always very humid and laden with substances once held in solution or suspension in the ground-water, but now taken up by the ascensional powers of evaporation. As sewage and house waste and dirt of all kinds contaminates the soil about any dwelling that has been used for any length of time, the soil air thereabouts is likely to be very impure, and great care should be taken that this be not sucked through cellar walls and floors into the house. This is especially liable to happen in the fall and winter when the fires are lighted and the in-door air is made much warmer than that outside. Cellar walls and floors must be made as near air-tight as possible and this care should see that the space underneath the hot air furnaces is hermetically sealed.

As sewage contaminates the soil about every dwelling more or less, we may here consider the effects of sewer-air or impure soil-air upon the human system. Sewer-air does not seem to be capable of producing very acute symptoms unless it be very concentrated or foul with impurities, though it may at any time carry the germs contagious diseases and be an exciting cause in their production. In a concentrated state it may cause asphyxia or attacks of vomiting, purging, headaches, prostration and even death. In houses the attacks are usually more insidious, the symptoms being pallor, languor, impaired health, frequent headaches and often anaemia.

Children suffer in nutrition and with them febrile attacks may be frequent. With all the power of resisting disease is lessened, illnesses are more severe and convalescence more prolonged. Sewer air and soil-air are supposed to have a causative influence as regards TyphoidFever, Bilious, Remittent and Yellow Fevers, Cholera, Diarrhoeas and Dysentery. It aggravates attacks of Erysipelas, Hospital Gangrene and all the Erythemata: Is probably harmful in all diseases, though especially those that affect the Alimentary tract rather than the Respiratory tract.

In Munich in 30 years the mortality from Typhoid Fever alone was reduced from 333 per I00000 to II per I00000, with a corresponding decrease in the morbidity, simply by the introduction of a proper system of sewers and the purification of the soil, soil-water and soil-air.

## LECTURE VI.

VENTILATION. In its widest sense means the making use of all the factors by which the purity of the air is maintained and its normal constituents kept in a constant proportion. Or, it may be said to mean the removal or dilution of the impurities which accumulate in and vitiate the atmosphere. But, not considering external ventilation, Parkes says "It will be desirable to restrict the term ventilation to the removal or dilution, by a supply of pure air, of the pulmonary and cutaneous exhalations of men, and of the products of the combustion of lights in ordinary dwellings, to which must be added in hospitals, the additional effluvia which proceed from the persons and discharges of the sick. All other causes of impurity in the air ought to be excluded by cleanliness, proper removal of solid and fluid excreta, and attention to the conditions surrounding dwellings."

But we also need external ventilation for streets and buildings, for "the health of a town depends largely upon the width of its streets, the general height of its dwellings, and the amount of yard space at the rear of each which separates it from its neighbor." Absence of sunlight and freely changing air have most injurious effects upon the human economy. Physicians should use all their influence to have new streets, at least, made sufficiently wide, and for new dwellings to have enough air-space back of and around them to allow the sunlight to enter and keep the air from becoming stagnant and foul. Much depends on the air external to dwellings as a factor in the enormous mortality from Tuberculosis and Phthisis. Bryson says that "in foul air the tubercle bacilli acquire mortally infective powers", and if this be true of one bacillus, why not of others? In the I5th. Ward of Philadelphia in the last I5 years, as Dr. Anders has shown, the mortality from Phthisis averaged on the streets running east and west, 3.7 per square on those over 40 ft. wide, if we except Callowhill and Wood Sts., both of which are wide, but both have the dwellings cut off from any ventilation in the rear and both have a high mortality, while on the streets below 40 ft. in width the mortality averaged 6.I deaths per square. Another reason for wide streets is that there is more opportunity for impurities in the soil-air escaping or being diluted and not being drawn into the dwelling houses. This is almost impossible in narrow streets.

As regards in-door ventilation, it has been shown that it is possible to get a very fair idea of the amount of organic impurity present in air by the sense of smell carefully employed. Going directly from fresh out-door air into the air to be examined no perceptible difference in the smell of the air is to be noticed till the $CO_2$ due to respiratory impurity reached .02%; at .04% the air seems

rather close and the organic matter begins to be perceptible; at .06% the air is close and the organic matter disagreeable; and at .09% the air is very close, the organic matter very offensive and it is impossible to make any further differentiation of impurity by the sense of smell. Moreover, it has been found by long experience that as long as the $CO_2$ from respiratory impurity does not exceed .02% no appreciable effect on health is produced. Therefore, we may take this as the measure of the maximum amount of respiratory impurity permissible in a properly ventilated room. And as no other ordinary impurity is so harmful as the respiratory impurity, we shall have good ventilation as long as we do not exceed the above limit.

Pettenkofer found that the average male adult gives off in repose about .7 cu.ft. $CO_2$ per hour, and the average amount for each person per hr. in a mixed assemblage may be taken to be .6 cu.ft. Exercise will, of course, largely increase this amount, so that for males it may reach 1.5 or 2 cu. ft. per hour. Taking .6 cu.ft. as the average, it is evident that in a room containing just 1000 cu.ft. for each inmate the respiratory impurity at the end of one hour in that room will be just .6 parts per 1000 or .06%, provided no outside air be admitted during the hour. But this is just three times the permissible amount of respiratory $CO_2$. Consequently to ventilate the room in accordance with our standard of purity the air in it must be changed three times in the course of every hour, the same number of inmates remaining; or in other words, each person requires 3000 cu.ft. of fresh air per hour. By means of the formula $D = \frac{e}{r}$, in which D equals the amount of fresh air delivered, e, the exhaled $CO_2$ per hr. and r the respiratory impurity, we may find the amount of respiratory impurity in a room, if we have given the number of persons, the time and the delivery of air per hr.; or the amount of air being delivered if we know the number of persons, the cubic space of the room and the total amount of $CO_2$ present. For adult males the quantity of air supplied must be more than that given above: at repose, from 3500 cu.ft. (100 cu.meters) to 3600 cu.ft. (1 cu.ft. per second.) At work still more, (from 5000 to 10000 cu.ft. per hr.), must be supplied to keep up the energies of the men. The above is the amount required when the human body is the only source of impurity.

If there are lights burning, additional air must be supplied to dilute the products of combustion, though it is not necessary to bring the $CO_2$ down to the limit given above, as here organic matter is not an accompanying impurity. A cu.ft. of coal gas in burning produces about two cu.ft. of $CO_2$, some CO and $SO_2$, and Wolpert calculates that 1800 cu.ft. of air are required to dilute this properly. One pound of oil produces about as much $CO_2$ and CO as ten feet of gas. But as the high temperature at which these products of combustion are generated makes them much lighter than the air and carries them to the top of the room, the amount of air supplied to dilute them need not be near so great, especially if sufficient outlets for their rapid escape be provided.

While among the healthy no foul odor of organic matter is noticed as long as the respiratory $CO_2$ does not exceed .02%, in hospitals and sick-rooms it is quite noticeable when the $CO_2$ reaches .0166%. So at least one-fourth more fresh air should be supplied per person; i.e., 4000 cu.ft. per head in mixed wards, from 5000 cu.ft. upwards in wards for adult males. In contagious diseases even more than this should be furnished as we must drive out and oxidize all the disease germs that we can in addition to the other impurities. The more fresh air the sick get the better, provided there be no injurious draughts. Even temperature should be sacrificed to ventilation.

If a room be small the air therein will have to be changed often the velocity at the inlets will be increased, uncomfortable draughts will be created and the air will not diffuse itself so thoroughly throughout the room. Experience shows that even when the air is properly warmed it cannot be changed much oftener than three times an hour without discomfort to the occupants of the room unless the ventilating apparatus be very perfect in its workings and, therefore expensive. Consequently, as 3000 cu.ft. per person per hour of fresh air is the average amount required, so the cubic space per head should be at least 1000 cu.ft., with a corresponding increase where the occupants are all males, are all at work, or are in hospitals.

Moreover, the floor space must not be too limited, as the solid impurities increase in proportion in the lower strata of the air as the floor space decreases and the depth increases. 10 or 12 ft. is usually the safest limit of height for ceilings, provided we are limited as to cubic space or the quantity of fresh air that can be supplied per hour. This is especially true of hospitals where the solid impurities are in greater excess and more dangerous, and where as much space as is possible is desired around each bed to lessen the risk of contagion. On the other hand, there is no objection to high ceilings if you are not limited as to floor space, pure air supply and heat, and they may be advisable in rooms where many lights are to be burned. But in ordinary rooms the minimum floor space should not be less than one-twelfth the cubic space. So in ordinary rooms there should be from 83 to 100 sq.ft. of floor space per head, the area increasing with the work done or the preponderance of adult males; and in hospitals each bed should have from 100 to 130 sq.ft., with a corresponding cubic space of from 1200 to 1800 cu.ft. These last figures may be modified somewhat in those hospitals where more perfect mechanical appliances secure a more frequent change of properly warmed air without injurious draughts; but an effort should always be made to give as much floor room as possible to each patient, especially in contagious diseases.

There are two sets of means by which the air is kept in motion and efficient ventilation produced: 1. By those forces continually acting in Nature, giving us Natural Ventilation; and 2. By those set in action by man, giving Artificial Ventilation. We almost always take advantage of and make use of some of the forces of natural ventilation in applying artificial ventilation. The three forces of natural ventilation are Diffusion, The Winds, and the Difference in Weight of volumes of air of different temperatures.

Though Diffusion is constantly taking place between all the gaseous constituents and impurities of the air and even goes on through brick and stone walls, it in itself is insufficient to keep the air altogether pure, though it does much to further this end. Moreover, suspended matters, not being gaseous but solid, are not changed or removed by it. The rate of diffusion is inversely as the sqare roots of the densities of the gases concerned.

A Wind is a natural movement of the air. Air expands 1/491 of its bulk at 32°F. for every degree F. it is heated, and consequently becomes lighter as its temperature increases. So winds are produced by the heating of the air by the sun's rays, by contact with heated plains of sand or expanses of water, etc. Winds are powerful agents for ventilation, a slight breeze passing through a room changing the air therein many times in the course of an hour and carrying out by its force the solid impurities left unaffected by diffusion: they will pass through walls of wood, brick or stone, though their

progress is arrested if there be much moisture in the wall,or if the walls be papered or plastered. Though the average movement of the wind is considerable and though it may be moving when it seems "still"it may become stagnant and fail us at a time when we need its perflating action most.But the greatest difficulty in applying them to ventilation is owing to the uncertainty of their direction and velocity,and the difficulty of regulating them. They may act well in summer when the extremes of temperature between in-door and out-door air is not great,and when doors and windoms may with safety be opened wide;but in winter a velocity of 5 or 6 ft. per second of the air is not to be borne unless it be previously warmed. But we may take advantage of the fact that small current with high velocity will set in motion a large volume of air,and that wind blowing across the top of a tube will cause an upward movement of air in the tube. It is to the latter action that the draught up an unused chimney is often due and one reason why they act as good ventilating outlets. To make use of these perflating and aspirating powers of the wind,and to prevent back-draughts down chimneys and pipes used for ventilating purposes,we make use of Cowls,either movable or fixed. In either case we can so arrange them that the force of the wind drives the air into the dwelling,(Perflation,)or sucks the air out of it,(Aspiration.) Very good systems of ventilation employing these have been put in operation,the air being warmed ,if necssary,by passing it through or over stoves,steam pipes,etc. They are especially useful where the inner air is colder than that externally and where artificial ventilation cannot be employed,as in holds of ships,basements,etc.

The most important force in natural ventilation is that represented by the movements caused by unequal weights of air. It is the same force that causes winds,but its action is far more widespread. If the air of an enclosed space be heated by fires or lights or by the bodies of men or animals,it will expand and become lighter,and if their be any communication between the two the colder outer air will rush in,pushing warmer lighter air to the top,and we shall have each of the apertures of the room acting as an inlet or outlet as the circumstances of the moment determine.And as the incoming air becomes heated it in turn will expand and escape and thus the movement will become continuous and remain so as long as the air of the room is warmer than that outside. And as the current thus produced is gentle and continuous,we should take advantage of it in whatever system of ventilation we adopt,as the most valuable of the natural forces at our command. This action is most powerful in winter when the difference in temperature between the in-door and outer air is greatest,and ceases when this difference becomes a zero quantity.

To determine the velocity of this influx or outgo of air we make use of the law that fluids pass through an opening in a partition with the velocity which a body would acquire in falling through a height equal to the difference in level of the fluid on the two sides of the partition. In the case of a current of air we substitute for the difference of level the difference in pressure on the two sides of the partition,and this is expressed by the difference in temperature on the two sides multiplied by the difference in height of the openings of entrance and exit. The velocity will be

$$8\sqrt{\frac{(\text{Diff. in temperature}) \times (\text{Diff. of Exit and Entrance.})}{491.}}$$

In actual practice we make use of a table derived from this formula, or else determine it directly by means of an air-meter, (Anemometer.) Allowance must be made for the friction of the air against the sides of the ducts and against itself. This amounts to from 1/4 to 1/2 of the theoretical delivery, according to the length, straightness, etc. of the inlets and outlets. With equal areas the loss is directly as the length of the tube or shaft: it is inversely as the diameter of the opening: For the same areas it is less the smaller the periphery of the openings: right angles diminish the current one-half: dust and dirt increases friction.

In making application of these forces of natural ventilation, no especial care is needed as to Diffusion, as it will always act as long as there is any communication between the exterior and interior. We cannot use the wind continually on account of the coldness of the out-door air in winter; but we should be able to employ it as often as possible on account of its great power for sweeping out solid impurities and thoroughly changing the air. Doors and windows should be so arranged as to gain full benefit of its action in summer and for a few moments, at least, each day in winter. The windows should be on the opposite sides of the room or adjoining rooms, and should open at the top, so that the air may not blow directly on those in the room but may first diffuse itself and be partially warmed. Some means should also be employed to divert the current toward the ceiling and to check it when it is too strong. This may be done by means of a strip of board under the lower sash, a frame of gauze at the top of the upper sash, double panes, etc. But we often have to exclude the wind, and then must depend on that movement produced by volumes of air of unequal temperatures. For this we must provide openings for the entrance and exit of air other than the windows and doors, and with these there will be a constant movement of air through the room as long as there is any difference of temperature. We should strive to give this movement a constant direction, so as to be sure that the air is from a pure source and to get the utmost service from our appliances. And as the temperature varies from time to time, and with it the current, some arrangement is needed for regulating the size of the openings, since the volume supplied equals the velocity multiplied by the area of the inlets. To supply 3000 cu.ft.per head per hr. at a velocity of 5 ft. per second requires an inlet opening of 24 sq.in.. In practice it will be better to have a larger opening, as we can only stand the above velocity when the air is well warmed. The area of outlets should be the same as of the inlets, for the expansion of the air is not great enough to require larger ones. Where much fresh air is required, it is better to have a number of inlets and outlets than one large one of each, as the distribution is then more certain. The air must be from a pure source: the inlet tubes should be short and easily cleaned, with no chance for the entrance of effluvia. The air should be admitted at the bottom of the room if warmed; if cold, it should only be allowed to come in near the ceiling that it may be warmed and diffused before reaching the inmates. The outlets should be at the top of the room if there be no way of heating the outgoing air. They should all be on the same level, else the highest will be the one of greatest discharge and often the only one. Where gas is used as an illuminant it may be employed to heat the outlet tubes, both to carry off the used air and the products of combustion. Outlet tubes should be protected from cold and kept as warm as possible.

ARTIFICIAL VENTILATION. We can consider at the same time with this subject the Methods of Heating Dwellings, because in this climate heat is the most economical and practical agent at our disposal for securing artificial ventilation and we may thus use our production of heat for two purposes. heating and ventilation. But remember that we cannot use a unit of heat for two purposes at once; if we use it for ventilation we cannot at the same time use it for heating a room. Artificial ventilation may be accomplished either by sucking air out of a room, (Extraction,) or by forcing it in, (Propulsion.) In the first method we can attain our object either by heating the air in the outlet or the outlet itself, or by making use of a fan, screw, steam- or water-jet. Of the first of these the common chimney is as good an example as any. As long as there is a fire in the grate or stove of the chimney there will be a constant upward current depending on the size of the fire and area of the chimney. Even with no fire thereis usually an upward current. The area of the chimney being known and the velocity found by means of the anemometer or calculated from the foregoing table, the amount of air leaving the room by way of the chimney. As the current up the chimney is quite strong when the fire is lightedall other openings in the room may act as inlets, especially if there be not too many and none be placed near the ceiling as outlets. This current up the chimney will then be practically equivalent to the amount of incoming air. The chimney should be provided with a damper where no special inlets have been provided to prevent the current becoming too strong and down draughts being set up in the chimney causing it to smoke. So also a smoky chimney may be often instantly remedied by opening a window or door to admit sufficient air. It is as hard to draw air out of a room without inlets as to force air into one with no outlets. On the other hand, the inlets may be large enough and likewise the outlets, but the air may be sucked in so fast that it is not properly warmed and the room remains cold. Here also a damper in the chimney is needed, or else an increase in the efficiency of the heating apparatus.

When we wish to make use of a fire to draw air from distant and non-communicating rooms, the ducts may be led into the chimney below or just above the fire, or better, into a flue or shaft alongside of or encircling the heated chimney. The draught is greater just above the fire than below it, but the ducts should not enter near the top of the chimney, for the temperature is lower there and the extracting power not so great. Besides, high winds may blow the smoke back into the rooms along with the foul air from them. Where the air-flue is alongside the chimney or encircles it, it should be as smooth as possible interiorly and should be carried up as high as the chimney itself to prevent down draughts. If possible, these by-shafts should only be alongside those chimneys that are being constantly used. The openings into the ducts from the rooms should be near the ceiling, to get the benefit of the high temperature of the upper strata of air. In hospitals or places where a constant supply of heat can be afforded, extraction shafts apart from chimneys may be used, but the above points should be observed. These shafts may be heated by fires at the bottom, by hot water or steam pipes either at the bottom or coiled around the sides, by steam jets at the bottom, etc., etc. In mines where large quantities of air must be supplied this system is used. There is an entrance and extraction shaft; fires are constantly kept up at the bottom of the latter, the air is drawn down through the former, diverted through all parts of the mine by partitions, and carried up through the extraction shaft.

In the foregoing methods we make use of heat and the third force of natural ventilation, the movement of heated bodies of air; but produce or supply the heat by artificial means. We may use a jet of steam or water to extract air through a shaft. It is said that a steam-jet sets in motion as much as 217 times its bulk of air. In these cases the openings of the foul air ducts into the shaft must be back of or behind the jet. Lastly, fans driven by steam or water power have been employed to suck out the air, though these are usually more efficient in forcing in fresh air. One of less than 14 ft. diameter at 60 revolutions per minute is said to extract 45000 cu. ft. per min. with a velocity of 782 ft. per minute.

In ventilation by propulsion large revolving fans are used. The advantage of this system of ventilation is its certainty as to direction of current and amount of air supplied, and the ease with which the quantity can be altered or measured. The disadvantages are the high cost of power in most cases , the chances of the engine or apparatus breaking down, and some difficulty in properly distributing the air. If the air be forced in through small openings or at too great a velocity it will not mix properly with the air of the room. The system needs close attention to details.

In cold countries there must be some resort to artificial heat in the winter season. The cold is depressing, uncomfortable and dangerous to the young and old and to women whose course of life keeps them much indoors, though well-fed, healthy adult men may not mind it much if accustomed to it. In this country we need warmer temperatures than in England on account of our drier climate. Evaporation, and consequent cooling of the body, takes place more rapidly here. In Great Britain they are accustomed to from 60° to 65°F., while we find from 65° to 75°F. to be but comfortable. However, most of the specific fevers, except Scarlet Fever do well in a cooler temperature, though most other diseases do better in a warm, dry air.

There are three kinds of heat; Radiant, which warms a body without warming the air through which the heat rays pass; Convected, the heat being conveyed from one place to another by means of warmed masses of air; and Conducted, the heat here being conveyed from one particle of a substance to another in contact with it. As far as air is concerned this last acts very slowly and for our purpose may be considered along with convection. Radiant heat is undoubtedly the best, but is most expensive. It does not bake the air or give any impurity thereto. As its intensity decreases with the square of the distance it can only be utilized in small rooms. The most common example of its use is the open fire-place, though we do have some radiation from hot stoves. It acts even through a strong current of air blowing against its source; and as with the open fire-place we have an open chimney and very efficient ventilation, such a method of obtaining it is to be commended where expense is not an obstacle to its use or where convected heat can also be utilized. There are three things, any two of which we may have as circumstances now are, but not the three together; viz., Good Ventilation, Efficient Heating and Cheapness. Convected heat is cheaper than radiant, and as it gives currents of air that aid greatly in ventilation, apparatus supplying it is most generally employed. The heated air may be conveyed from place to place by suitable appliances and thus be used to heat large spaces. Moreover, it can be easily stored and its tempera ture and purity regulated.

Consequently, convected heat is more practicable and available for heating dwellings than radiant. Where open fire-places are used the sides and bagks of the grates should be so arranged that every ray of heat is thrown out into the room. The width of the back should be one-third that of the front, the depth from front to back equal to the width of the back, and the back tipped forward to prevent the upward rays passing up the chimney, and at the same time contracting the flue and lessening the draught. The fire-place should also be so constructed that fresh air may be brought in from out of doors to a chamber back of the fire, there heated, and then discharged through register openings into the room. This will increase the ventilation, give a large supply of warmed fresh air and utilize heat otherwise wasted. Here we have both radiant and convected heat and a near approach to cheapness, good heating and good ventilation. The air chamber should not be too small and the heated surface should be as large as possible. As much surface of stoves should be exposed as is possible without decreasing heating capacity, in order to have as much radiant heat as possible. Or it is often advantageous to surround a stove with an iron cylinder and to have this communicate at the bottom with the out-door air. The air passing between the stove and cylinder is heated and in turn both heats and ventilates the room without any disagreeable current. The damper of a stovepipe should never be entirely closed while the stove is being used, else the gases of combustion may be forced into the room with serious or fatal results. Hot air furnaces give a supply of convected but no radiant heat. Their fresh air supply should be from a clean source, the inlet tubes as short and straight as possible, and these should be cleaned regularly and often and be screened against the entrance of vermin and refuse. The cross-section of the cold air or inlet tube should be at least 2/3 the area of those of all the hot air pipes from the furnace combined, and and should have a damper to regulate the cold air supply. The furnace should have a large expanse of heated surface, so that the air may not be warmed too much even in the coldest weather. The bottom should be hermetically sealed against the entrance of the soil air, and all joints between the fire- and air-chambers must be tight to keep the gases of combustion from passing into the house. The hot-air ducts should be round or square, not flat, to lessen friction, and should be as straight and as nearly perpendicular as possible and have divergent openings for the same reason. If possible, they ought not to open into rooms to face prevailing winds, else all passage of air up through them will often be checked. The air from furnaces, or from steam or hot-water coils, should not be heated to more than 120°F., but enough must be supplied to maintain a proper temperature in the rooms. Air heated very hot is very dry and has an offensive smell. Water must be supplied to the hot-air chamber of the furnace to satisfy the demand of the heated air for more moisture and to prevent it from taking it from our bodies. Must take care not to have the sweat glands too active in the house and then to check that action suddenly by going into the cold outer air.

In heating by hot water or by steam we may have either the Direct or Indirect system or a combination of both. In the direct system the pipes are carried directly to the rooms to be heated and the coils placed therein, giving both radiant and convected heat. In the indirect, the coils are placed in air-ducts or chambers, the air thus heated and then conveyed to the rooms as in the case of hot-air furnaces, thus giving convected heat alone. We may also have a high- or low-pressure system with water or steam pipes.

WATER. Next to air,water is the most important of all substances necessary to human life. Man can probably not survive more than ten days without water. We must not only have enough to supply the internal wants of the body and to replace that lost by excretion,evaporation and respiration,but,from a sanitary point of view,we need a plentiful supply to maintain cleanliness of bodies,clothing and dwellings and to remove sewage,excreta,etc. from the vicinity of inhabited places. The care of furnishing water in abundance and of maintaining its purity is thus strictly within the domain of the Sanitarian and the Physician.

Practically,all water has at some time or other fallen upon the earth from the air in the form of rain,hail,snow or dew;but when we speak of the sources of our drinking water,we have reference rather to the place or locality from which we collect it. The rain,etc. on reaching the earth is disposed of in three ways: 1. Part at once evaporates, 2. Part flows off according to the slope of the ground, 3. Part sinks into the soil. The ratio which these three parts bear to one another depends on time,place,character of soil,intensity of rain-fall,etc. Consequently,we take as the sources of potable water 1.Collections of it received as it falls from the clouds, 2.Pools or streams that receive it as it flows away in one direction or another, 3.Collections held in the porous and water-bearing strata of the earth,and 4.The springs caused by the outcropping of these strata below the level of the water line in them. But before going further,it will be well to know what amount of water is required by the body for its daily needs,that we may be able to judge not only whether a given source furnishes pure water,but also whether it gives a sufficient supply of it. The average adult requires from 70 f.oz. to 100 f.oz. per day for nutrition alone,about 1/3 of this being a component part of the food,and the rest to be taken in as drink. In addition to this we must supply a sufficiency for cooking and for washing the food,body,clothing,household utensils and parts of the house itself,and to remove the household waste and sewage through the drains and sewers provided for that purpose. Cleanliness is an essential requisite for the preservation of health,and cleanly habits should be inculcated among all classes and every facility provided for removing filth of all kinds from persons,dwellings and clothes. This cannot be done without a fair supply of water. Experience shows that about 25 gallons per head per day should be furnished for the above purposes;and as the quantity used by animals,manufacturing establishments,municipal needs,etc. must be added to this,50 or even more gallons should be supplied daily per head wherever it is at all possible. As only a small portion of this is needed for the internal needs of the body,it has been suggested that two kinds of water be furnished,one for drinking,cooking and the washing of the body,to which especial attention as to purity is to be given,and another for all other purposes with indifferent regard as to purity,excepting possibly the hardness. This would enable the authorities to furnish a purer water for those needs where purity is of the greatest importance,and would obviate the need of furnishing abundantly pure water for all purposes. But this scheme would necessitate a double set of reservoirs,mains,distributing apparatus,etc.,thus increasing the cost,and there would always be the danger of the careless or ignorant using the impure water for bodily needs,thus increasing the bad results that we wish to avoid. Where we can have an abundance of pure water for all purposes,if the autorities but take pains to furnish it to us,it will be best then to have but one supply to our dwellings,though there may be no objection to another for facories,city uses,etc.

But the house supply should be as pure and abundant as money and the highest sanitary skill can make it.

Considering the sources, rain water is theoretically the purest at our command, but in reality it takes up many impurities from the air in its fall, both solid and gaseous, and by the time it reaches the earth contains $NH_3$, $HNO_2$, $HNO_3$, and in towns $SO_2$, soot many bacteria and even microscopic plants. Moreover the collecting surface on which it falls is apt to be covered with dust and impurities of all kinds, especially after continued dry weather, which being taken up by the rain water render it unfit for use. If rain water must be used, there should be some arrangement for turning aside from the cistern the first portion of rain that falls, and if this be done and the remainder filtered and stored in proper receptacles, the water may be of excellent quality. The great difficulty, however, is that dependence is here placed on a very uncertain source which is apt to fail when an increased supply is most needed. Rain-water may be collected from roofs or from a plot of ground covered for the purpose with cement or slate and sloping towards a cistern.
The average rainfall for Philadelphia and vicinity is about 39 ins. In very wet years it is about 1/3 more than the average; in very dry years, about 1/3 less than the average. Each inch of rainfall gives 4.67 gallons per sq.yd. of area on which it falls, equal to 22617 gallons per acre. Counting the average rain-fall at 30 in., the loss by evaporation at 20%, and allowing 60 sq.ft. per head, the supply would only be about 2 gallons per day per head, or just about enough for drinking or cooking purposes ; not enough for other needs.

Rain water should be filtered before passing into the cistern, and the cistern should give no unpleasant taste or injurious substance to the water, should be placed so as to keep the water cool, receive no rubbish nor impurity, and should be cleaned regularly and often enough to keep the water sweet and wholesome. The overflow pipe should not open into sewer pipe or drain but into the open air. As rain water contains considerable $CO_2$, its solvent powers are great and it will rapidly take up lead, zinc or iron from the linings of cisterns. So linings of these materials should not be used. This, however, does not apply to the rustless iron now being much used, but galvanized iron should not be used as it may give up zinc to the water. Cement should be used in lining brick or stone cisterns instead of mortar, as the latter gives up lime to the water and renders it hard. Rain water is especially valuable in cooking and washing on account of its softness. Water is said to be hard when it contains an excess of the salts of lime or magnesia in solution. Hardness due to the presence of calcium bicarbonate is said to be temporary, because it is lost on boiling, one molecule of the $CO_2$ being driven off and leaving the insoluble calcium carbonate behind. Hardness due to the other salts of Ca and Mg is called permanent, because it is not lost by boiling. In cooking with water temporarily hard the chalk is precipitated on the sides and bottom of the vessel and, being a non-conductor, prevents the passage of heat and wastes fuel. In washing the Ca and Mg salts unite with the fatty acids of the soap and prevent the formation of a lather. One grain of chalk wastes about eight grains of soap. We call a water hard when it contains more than 10 grains of chalk, or its equivalent in the salts of Ca or Mg, per gallon. Rain water rarely has more than one-half a grain per gallon, so is especially valuable in kitchen and laundry. Underground cisterns for storing rain water should be condemned as being liable to sewage contamination unless they be perfectly water-tight except at inlet and outlet.

A water supply taken from rivers or smaller streams not polluted by the refuse and sewage from towns, factories or cultivated farm lands higher up the stream may be fairly pure and safe. The best water of this kind will be from hilly and uninhabited, uncultivated tracts, with small streams fed by constant springs and uniting to form rapid creeks and rivers. Such water may be tinged slightly with vegetable or mineral matter, but in general such coloration is harmless. For storage, dams may be thrown across convenient valleys, thus impounding the water, keeping it exposed to the oxidizing and aerating action of the air and allowing the solid impurities to settle to the bottom. Small lakes and ponds may be used to add to supplies of this kind provided they be not stagnant nor have much decaying matter along their banks. But water from a stream which has received the sewage from a village or town of any size, or the refuse of factories, or the drainage from large tracts of cultivated land should be considered as at least suspicious. River waters are generally hard, and may contain any of the minerals in the soils over which they pass, but the greater danger is from impurities of animal origin poured into them along their course. It is not safe to depend on the self purification of sewage contaminated rivers, as was formerly done, though much of the sewage and filth is destroyed, part by oxidization by the air in the water, especially in rivers flowing over dams, rapids, etc., part by subsidence or deposition along the banks, part by fish and animalculae, and much by the myriads of bacteria which such water always contains. If no additional pollution is added, what is left unchanged by the above forces is still further diluted by the supplies of pure water that every stream receives from springs along its banks or in its bed and from tributary streamlets, so that, though the water may never become as pure as it was originally, it may by proper filtration or treatment be made a usable water. But where the proportion of filth exceeds a certain percentage, or where sewage is being constantly added, the O is rapidly used, oxidization ceases, fish and animalculae cannot live in the water for lack of O, and though the heavier and larger particles of the sewage sink to the bottom or stick to the sides, they are stirred up and set in motion by any increase in the velocity of the current. The only active agents in the destruction of foul matter are the bacteria, and in themselves they are insufficient for the task. But the greatest danger from sewage contamination is that it may add the germs of contagious diseases to the water, which multiplying rapidly in such a medium and not being certainly removed or destroyed by any practical means of filtration or purification of the water on a large scale, greatly increase the dangers from its use. And as it never can be certainly told when a water so contaminated becomes safe for use again, and since the population of a town and the consequent sewage production is constantly increasing while the quantity of the water in the straam is about the same from year to year, the use of such water should be avoided if possible.

Water from large fresh water lakes is of the best quality, provided the intake is so far out as to escape all danger of sewage contamination. Water from small lakes and storage reservoirs may become offensive to taste and smell through the growth in them of minute vegetable organisms, but it is not known that these are prejudicial to health.

That part of the rain- or snow-water that soaks into the soil goes to keep up the underground supplies of water,, excepting the what is needed for nutrition by the roots of trees and vegetation. This water, as it sinks through the soil, loses much of its organic matter, but takes up considerable $CO_2$ from the soil air.

Ordinarily rain water that has percolated through the soil is remarkably pure and wholesome, though the excess of $CO_2$ that it contains increases its solvent powers and it may take up some of the mineral constituents of the soils through which it passes. This water sinks through the ground till at some level or other it reaches an impermeable stratum where it is retained in natural basins or else escapes at some outcropping of the stratum below the ground-water level, thus forming a spring. The level of the water in these underground reservoirs is constantly changing, according to the season, rainfall, discharge from springs, etc., though the variation is usually regular and differs little from year to year. In chalk the percolation is about 37% of the rainfall, in sandstone, 25%, in limestone, 20%, and in loose sand and gravel, about 90%. It is from wells sunk to these water-bearing strata and from springs that the majority of people not living in towns supplied by water-works obtain their water supply. These underground bodies of water are constantly moving toward outlets at some point or other. The current is not rapid, as in bodies of water free to move without obstruction, but is very slow, owing to the friction and capillary force of the particles of soil through which it passes. For the same reason the surface of this water is not horizontal but curved, the curve sharpest nearest the outlet. So also, the difference in level beween high and low water will be least nearest the outlet, and the higher the level the greater the fall to the outlet from the highest point and the greater the discharge. As has been said, the water passing through the soil loses much of its organic matter, but takes up considerable $CO_2$ and often a marked proportion of mineral matters. When the quantities of these mineral substances become so great as to give the water a medicinal value or objectionable taste we call it a Mineral Water; but when the inorganic matter does not render the water objectionable to the taste nor too hard, it will probably be found to be purer than that from almost any other so source. But this does not hold good for ordinary wells or where the water passes almost directly from surface to outlet, for in both cases the prolonged filtering action of the soil and the removal of organic matter is missed. Water passes almost directly from the surface to the well and may carry with it solutions of all the impurities polluting the soil about the well. Wells drain an area in ordinary soils whose radius is at least four times the depth of the well; and there are few wells about which such an area is not subject to dangerous pollution. Especialy about human dwellings is the filth apt to be carried into the well, for the sewage and dirt of almost every kind is constantly increasing in quantity in the soil about a house, with always the danger of it also receiving the germs of disease. Only such parts of this pollution as can be dissolved may reach the well water, together with the bacteria which pass freely through almost all soils, and it is a strange fact that many waters thus polluted are sparkling and clear with even a pleasant taste and no bad odor, so that all suspicion as to their character may be wanting. There is always danger that this contamination may become so concentrated as to produce very serious results, even if disease germs be absent, and this may occur in either of two ways; I The well may be so deep or the condition of the soil such that in ordinary weather the liquid passing through the sewage is so purified as to give no bad properties to the water; but the soil is becoming more and more polluted with impurities all the time, and if now heavy rains or continued wet weather supervene, we may have more and more of these impurities disolved and carried into the well until at last the proportion of impurity in the water passes the safety line and we have marked illness or increased predisposition to

disease as a result;or 2. In dry weather the ground-water is lowered to such an extent that the impurities become concentrated and dangerous enough to cause sickness,even though there be no further pollution of the soil about the well;or else,the water level in the well being lowered,a greater area is drained and new sources of sewage empty into the well. Shallow wels are those under 50 ft. in depth which do not pierce an impermeable stratum of earth: deep wels are those over 50 ft. deep or which do go through an impermeable stratum. The latter are the best,especially if they be cased so as to shut out the water from the soil about the mouth and upper part of the well,for then the water has to pass through a considerable depth of earth and is well filtered before it can reach the well. All wells should be walled and cased for a considerable depth and should have a good curb to keep out splashings and soakings of muddy and impure water and to make the water traverse as much soil as possible before entering the well. The area about them should be kept clean and all possible sources of contamination removed. Artesian wells are very deep wells piercing one or more impermeable strata,and in which the water rises and flows out of the mouth.They draw their water from a permeable stratum between two impermeable ones and which has its only outcroppings at a higher level than the mouth of the well. The water accumulating in this reservoir rises above the level of the mouth and is forced out as soon as an opening is made and the impermeable strata above pierced. The water from artesian wells,having filtered through the earth for a long distance,is apt to be very free from organic matters and for the same reasons to be heavily charged with mineral matters. If these latter be not present the water will probably be of excellent quality,though if the well be very deep it may be too warm for immediate use for drinking.

The decision as to the purity of any water must in each case be determined by all the circumstances available which relate to it, and these should all be thoroughly investigated before rendering a decision,for some may counteract others. However,other things being equal,the value of a water will probably be in accord with the following table:

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| Wholesome: | 1. Spring Water; | Very Palatable. |
| | 2. Deep Well Water; | |
| | 3. Water from Unpolluted Streams; | Moderately Palatable. |
| Suspicious: | 4. Stored Rain Water; | |
| | 5. Surface Water from Cultivated Land; | |
| Dangerous: | 6. Sewage-polluted River Water; | Palatable. |
| | 7. Shallow Well Water; | |

A good potable water should be perfectly clear,free from odor or taste,cool,well aerated and,if possible,soft or with only a very mild degree of hardness. Circumstances must determine the amount of dissolved matters permissible;what is an excess in one case might not be so in another. We may also classify waters as follows: 1. Pure and wholesome water, 2. Usable water, 3. Suspicious water, 4. Impure water. (See table following Lectures on Water.) Waters of the first two classes may be used without filtration: those of the third class should be filtered before distribution,and also at the house before use,if possible;a purer source should be sought out,or else all sewage pollution prevented: those of the fourth class should not be used at all except when absolutely necessary,and then only after purification by all means at command. Inasmuch as most large cities must from necessity furnish a water

of the second or third, and occasionally even the fourth, class, such water should be purified as much as possible before distribution by storage in settling reservoirs till most of the solid impurities fall to the bottom, and also by some effective system of filtration. As much of the organic matter is oxidized while the water is standing in the settling tanks, a water originally suspicious or worse may be made quite usable by a proper use of the above means. Not only must the storage reservoirs and filtering apparatus be kept clean, but care must be had that the distributing apparatus does not allow sewer air or sewage to be drawn in through leaks in the mains at times when the flow of water is intermittent, and that lead pipes be not used in the houses if the water is such that it acts on that metal. Pure waters and those containing most O act most powerfully on lead; also those containing organic nitrates and nitrites, especially $NH_4NO_2$. Waters containing $CO_2$ and the salts of Ca and Mg and those free of absorbed gases act least on lead, and $CO_2$ seems to protect lead by forming a carbonate, though a great excess of the gas may tend to re-dissolve this. Lead is more easily acted upon if other metals are in contact with it. Water containing more than 1/20 of a grain of lead per gallon should not be used. Lead pipes should not be used to supply water unless suitable tests show that the water does not affect them. New pipes may give up lead for a time to the water till the coating of insoluble carbonate is formed within them, and water should not be used from them till tests show less than 1/20 gr. per gallon. A good test for lead is the following; Place 50 c.c. of the water in a white dish, add 2 drops of $(NH_4)_2S$, and stir with a glass rod. A dark coloration indicates either Fe, Pb or Cu. If the color is due to Fe it will be removed by adding a few drops of HCl; any dark color left after adding the acid is due to Pb or Cu, either of which is dangerous. This test will show .1 gr. of Pb per gallon, and water giving it should not be used.

Often well-water is the only kind available, especially in country districts. We then have to take care that all impurities are kept out of the well, and if we do this we may have water of excellent quality. The well must be as far as possible from any source of contamination, especially if that be constant. Wells drain a large area. As the ground-water has a constant movement in the direction of natural outlets, the well should be so placed that the current flows from it <u>toward</u> any cess-pool or other source of pollution. The direction of the underground current can be determined by noting the location of the nearest spring or watercourse, toward which the ground-water is probably flowing, or by observing the dip of the underlying strata. Or holes may be sunk about the well to the water and a quantity of salt or aniline dye thrown into one of them; after a time either the test for salt or the colr will indicate the direction of the current. If a well be much deeper than a neighboring cess-pool it may drain from the latter even against the current if the water in the well be suddenly lowered. If possible, it is best for wells that must be deep to go through an impermeable stratum and to be cased down to this stratum. At any rate the well should be cased for some distance to keep out the surface water, and should have a good curb and paving about it. The water of the well should be frequently tested for chlorides and nitrates, as indicating sewage contamination, and this should be done especially after heavy rains and when the water in the well becomes very low. The taste and odor of the water should be noted, especialy after standing or being heated. Some other source should be sought whenever the tests show comtamination, or when there are cases of infectious diseases near at hand. Filtration is to be recommended. Wells in thickly settled towns should not be used, as the soil is saturated with filth.

PURIFICATION OF WATER. The impurities in water are solid suspended matters or dissolved substances. The turbidity is due to solid matters; water free from these is clear, though it may have a deep color from dissolved matters. Moreover, a clear water may contain such solid bodies as bacteria, ova of parasites, etc., which are too minute to be seen with the naked eye. The impurities, whether solid or dissolved, may be either organic or inorganic. Whether harmless or not, they should all be removed in so far as is possible from all supplies of drinking water. This may be done to a considerable extent on a large scale before the water is distributed to consumers, and should also be done by the latter on a small scale if the water is not already clean and within the limits of safety when they receive it. Purification on a large scale may be by either or all of three methods; subsidence, chemical treatment and filtration. The first consists in allowing the water to stand in large reservoirs till the greater part of the suspended matters have fallen to the bottom. Oxidization taking place at the same time, these two processes do much to improve the water. If the water contains an excess of mineral substances or is very hard it is often advantageous to treat it chemically. Where the hardness is due to $CaCO_3CO_2$ (calcium bicarbonate) this can be removed by the addition of a solution of CaO to the water. Clark's process, based on this principle, is as follows; About 14 or 15 cwt. of lime is allowed to each million gallons. The lime is slaked in a tank into which the water to be treated flows; the whole is then well stirred and allowed to stand for 12 hours, when the water is drawn off the tank cleaned and the process repeated. The process depends on the fact that while the bicarbonate of calcium is soluble the carbonate is not. So when the CaO is added each molecule of this latter takes one of the molecules of $CO_2$ from the bicarbonate, thus giving two molecules of the insoluble carbonate instead of one each of the bicarbonate and the oxide. $CaO + CaCO_3CO_2 = 2CaCO_3$. The insoluble carbonate is, of course, at once precipitated. The same result occurs if the water be boiled, one molecule of $CO_2$ being driven off by the heat and leaving the insoluble carbonate, but this is of necessity impracticable in the treatment of the immense quantities of water needed for a community.

If alum be added to water which contains a little chalk in solution a bulky and flocculent precipitate of calcium sulphate and aluminium hydrate is formed, which entangles in it and carries down the other suspended impurities in the water. About 6 grains of alum per gallon is needed, and if just the right proportion be used and the water properly filtered no alum will be left in the water. The above processes remove most of the suspended but do not affect the dissolved impurities in the water. Filtration is especially valuable in connection with either of these processes. In using it on a large scale the water may be allowed to flow, after subsidence or chemical treatment, on to large filter beds made of fine sand and gravel or of magnetic carbide of iron and sand. In the former, the lower layer is of well packed gravel from two to three feet thick, which need never be changed. This is covered with fine sharp sand to the depth of 1 or 2 ft., which must be periodically cleaned, as its oxidizing action ceases when the particles become encrusted with the impurities filtered out of the water. Such a filter bed will allow about 2 gallons per hour to pass through each sq.ft. of area if rightly packed, and will not only remove the suspended matters but a great proportion of the dissolved organic matters and of the living micro-organisms. The longer the water remains in the settling tanks, the thicker the layers of sand, the oftener the sand is cleaned and renewed, and the slower the water filters through the beds, the purer it will be.

Magnetic carbide of iron has the power of ~~oxidizing~~ dissolved organic matters to a considerable extent, and may be substituted for the gravel in the beds just described. It need never be renewed, provided it is aerated from time to time by a proper intermission of the filtration. Spongy iron is another good filtering material having good oxidizing powers, but it loses its efficiency after a time and must be renewed. It must be kept covered with water or it will cake and lose its power. We cannot hope by any of the means given to render a foul water perfectly pure and good, but can improve its quality and render it fit for use.

Domestic Purification. Boiling destroys living organisms and disease germs, but we are not yet certain that we at the same time decompose the depressing alkaloids, etc. which these germs have already produced. Boiling also drives off the $CO_2$ and other gases of the waterand causes the precipitation of many mineral substances held in solution by these gases. This is especially the case where the water is hard from the presence of calcium bicarbonate but iron is also thrown down by boiling. If the water contains a very fine sediment, not removed by settling or filtration, it may be advantageous to add a little alum and chalk to produce the flocculent precipitate before described. Potassium permanganate has little effect in purifying a foul water, though iron filings may do a little good by favoring oxidization. Tannin is thought to destroy living microorganisms, and a harmful water may often be made usable by boiling with tea leaves or other astringents. Citric acid is said to destroy algae. Aeration and agitation improve a water after distillation or boiling by restoring O and by oxidizing organic matters. Organic matters are got rid of by boiling, exposure to air, agitation alum, astringents, charcoal, etc. Carbonate of lime by boiling and by adding caustic lime. Iron by boiling and by adding lime-water. Calcium and magnesium chloride and sulphate cannot be removed. Some plants purify by the O they give to the water.

Filters. Domestic filters are dangerous and may give much more impurity to the water than they take from it unless they be properly cared for. What a filter takes from a water is left behind in the filter unless otherwise removed, and an accumulation of impurities cannot improve the water passing through it. The filter wil become clogged, the organic matters undergo putrefaction and furnish a good culture medium for bacteria, and these will be carried on through in the water. The size of a filter must limit the work it can do, whatever the materials used. The requisites of a good filter are: I. That every part shall be easily accessible, for cleaning or renewing the medium; 2. That the medium have a sufficient purifying power and be present in sufficient quantity; 3. That the medium give nothing to the water favoring the growth of low forms of life; 4. That the purifying power be reasonably lasting; 5. That there be nothing in the construction of the filter itself capable of undergoing putrefaction or of yielding metallic or other impurities to the water; 6. That the filtering material shall not clog and that the flow of water be reasonably rapid; 7. That the medium be such that it can be readily cleansed and even sterilized, or else so cheap that its removal may not be neglected on that account when necessary. Every house filter should have a settling tank to remove as much of the solid matter as possible and thus prolong the safe use of the filter. Whenever practicable the water should be brought in at the bottom of the filter and there should be a space between it and the filtering material to allow the suspended matters to fall away from the latter. If carefully renewed or cleansed at proper intervals, such a filter should give good water ordinarily.

Owing to their minuteness,disease germs and bacteria pass thro' most filtering media,and the only safeguard against them is to boil the water whenever their presence is suspected. Filters in which the material is cemented up so that it cannot be removed for cleaning or renewal should not be used. Sponge,wool,etc. should not be used as they are liable to decompose,give organic matter to the water,and cannot be thoroughly cleaned. Small tap filters are insufficient for the work required of them. Filters should not be put in cisterns. Block filters are undesirable: they should be frequently brushed and scraped and cleaned with permanganate solution. Pocket filters are simply strainers and have little oxidizing power.

The best filtering media are sand,animal charcoal,magnetic carbide of iron,spongy iron,carferal and asbestos. Unglazed porcelain, as is used in the Pasteur-Chamberland filter,is an excellent medium and is probably absolutely germ proof,but its filtering action is slow and it must be frequently cleaned.It can be sterilized by dry heat of a high degree. Stone filters may be good,but are apt to be slow and must be cleaned often. Sand has fair filtering properties and makes a good first layer for a filter because it is cheap,can be easily renewed or cleaned and stops practically all the solid matters,besides oxidizing somewhat the organic matters. The particles should be clean,angular and sharp and not too fine,and should be cleaned often by boiling,washing or heating to redness. Where it is to be used in filters having the water entering below,it can be held in place by a layer of asbestos cloth on a sieve or grating. Asbestos makes a good filter,except that its oxidizing powers are slight and it allows albuminous matter and possibly disease germs to pass. When fresh,Animal Charcoal is an excellent material,as it removes suspended matters and and both dissolved organic and mineral dissolvesubstances,and even color. It acts both mechanically and chemically,and with a good bulk of it water may pass through very rapidly and be well purified. But after a time it ceases to be efficient,and water must not be left in contact with it long,as it will give up organic matter to the water again,as well as phosphate of lime,the latter favoring the development of micro-organisms.Moreover,fresh organic matter,and possibly germs,pass through it,though dead or decomposing matter is rapidly destroyed. It should be changed or cleaned every three months,oftener if the water is very bad. Magnetic carbide of iron is one of the best filtering materials. It considerable power in oxidizing organic matters,converting them into nitrates and nitrites,the action being greater the longer the water is in contact with it. If sand be used to remove solid matters so that the water reaches the carbide perfectly clear and if the sand be frequently renewed,the carbide need never be changed,but the filtration must be intermittent so that the carbide may be properly aerated. Spongy Iron has an action similar to that of the carbide on organic matter and,like it, the action is the greater the longer the contact. It is said to act by decomposing water into H & O,the latter acting on the organic matter,and it retains its properties for a long time. It must be kept covered with water and must be renewed about once a year. Carferal is a mixture of carbon, iron and clay and has good oxidizing properties,but is inferior to spongy iron and must be renewed as often as once a year. The last three substances oxidize all matters liable to be harmful and give up nothing to the water favorable to organic life. The little iron they give to the water may be removed by passing it through pyrolusite,a crude oxide of manganese.

Ice should not be added to filtered or drinking water,as bacteria and disease germs are not all destroyed by freezing for a long time.

Diseases Produced by Impure Water. A polluted water may carry the germs of specific diseases, or it may produce or favor the development of diseases which are not due to specific germs. But of at least equal importance from the sanitarians' view is the depressed state of the system that the habitual use of impure drinking water causes and the predisposition to disease that ensues.

The non-infectious diseases likely to be caused by impurities in the drinking water are primarily those affecting the alimentary tract, as the Dyspepsias, Diarrhoea and any disturbances having their origin in severe intestinal irritation. Impure water, even though it do not contain the specific germ, may have much to do in bringing on an attack of true Dysentery by so irritating the lower intestine as to make it especially receptive to the cause of the disease when introduced from an other source. Large quantities of the sulphates of Ca and Mg are thought to have special effect in causing Dyspepsia, with loss of appetite, pain at epigastrium, etc. Iron in water is also prone to produce constipation, headache, loss of appetite and malaise. Diarrhoea may be produced by any of the following impurities in water; suspended substances of any kind, especially faecal matters, disolved animal, vegetable or mineral matter, or fetid gases. The diarrhoea may be so severe as to strongly simulate true Dysentery, and cause doubt as to the diagnosis. By the power of accomodation and through long habit a community may become protected against an impure water as to manifest no striking symptoms, while strangers may be seriously affected by it. However, the health of those accustomed to it will probably be found in most cases to be depressed and far from good. Two other diseases supposed to be due to mineral or inorganic impurities are the formation of Calculi in the bladder, and Goitre though the true relation of impure drinking water to these diseases is unsettled. "It has long been a popular opinion that drinking lime waters gives rise to calculi of the oxalate and phosphate of Ca", and "the opinion that impure water is the cause of goitre is as old as Hippocrates and Aristotle." Certain metals may also be taken up either from the earth's strata or from the lining of cisterns, and may produce their characteristic and poisonous symptoms in the system.

Of the infectious diseases, germs of Malaria, Typhoid Fever, Cholera and Dysentery may undoubtedly be carried into the system by the drinking water, while there is strong probability as to the same being true of Yelow Fever, Scarlet Fever, Diphtheria and kindred diseases. But as with the impurities causing non-infectious diseases, so water containing disease germs may be used for a long time by those accustomed to it without the development of the disease, and it may only be after the system is weakened by excesses or other predisposing causes that the infectious disease manifests itself. Or it may be that only strangers and not the acclimated inhabitants incur the disease. (See the case of the "Argo", -malarial poisoning, -in Parkes' Hygiene: also the report of the outbreaks of Typhoid Fever at Lausen, -Pepper's System of Med., -and at Plymouth, Pa., -Rohe's Hygiene, and of the Cholera case in London, -Rohe: and note that these cases were reported before the acceptance of the germ-theory.

The ova of certain parasites, as of the tape- or round-worm, may be taken into the system along with drinking water containing them. Regarding the foregoing, Parkes gives these conclusions:

I. An endemic of Diarrhoea in a community is almost always owing to either impure air, impure water or bad food. If it affects a number of persons suddenly, it is probably owing to one of the last two causes, and if it extends over many families, almost certainly to

water. But as the cause of the impurity may be transient, it is not easy to find experimental proof. 2. Diarrhoea or Dysentery constantly affecting a community, or returning periodically at certain times of the year, is far more likely to be produced by bad water than by any other cause. 3. A very sudden and localized outbreak of either Typhoid Fever or Cholera is almost certainly owing to the introduction of the poison by water. 4. The same fact holds good in malarial fevers, and, especially if the cases are very grave, a possible introduction by water should be inquired into. 5. The introduction of the ova of certain entozoa by means of water is proved in some cases,-probable in others. 6. Although it is not at present possible to assign to every impurity in water its exact share in the production of disease, or prove the precise influence on public health of water which is not extremely impure, it appears certain that the health of a community always improves when an abundant and pure water supply is given; and, apart from this actual evidence, we are entitled to conclude from other considerations that abundant and good water is a prime sanitary necessity.

The Examination of a Drinking Water should have regard to its physical, bacteriological and chemical properties, as well as to a consideration of all circumstances affecting its source, storage and distribution. A decision on the purity of a water should be governed by all the circumstances available; whether it is well, spring, rain or river water, whether at any time exposed to pollution, in what kind of a cistern or reservoir has it been stored, etc., etc.

A physical examination considers Color, Clearness, Sediment, Lustre, Taste and Smell. The color is judged by allowing the sediment to settle and pouring off the supernatant water into a glass vessel about 24 in. high, and then comparing its color with that of distilled water in a similar vessel placed alongside, looking down from above through them both upon a white surface. Pure water has a bluish tint, but most waters are grayish, greenish-yellow or brown. Yellow or brown waters are suspicious, as the color may be due to animal matter or sewage, though vegetable matters or iron may give the same colors. Green waters are usually harmless, owing their color to vegetable matters. The clearness of a water is estimated in the same way as above, except that the sediment is to be shaken up with the water. The depth needed to obscure print may be used as an index. Very turbid water should be allowed to settle or be filtered before use, as the solid matter may cause gastro-intestinal irritation mechanically. Sometimes the solid matter will not settle, owing to the minuteness and lightness of the particles. The sediment may be roughly judged by the eye as to whether it is mineral or vegetable. Some of the larger animalculae may be detected; likewise the presence of iron. The lustre is supposed to indicate the amount of aeration It may be nil, dull, vitreous or adamantine. Any badly tasting water should be considered suspicious. Dissolved animal matters may be tasteless, but suspended matters give a peculiar taste, whether animal or vegetable. Iron is the only mineral that can be tasted in smallquantities. Good water depends for its taste upon its gases; water free from gas tastes flat. The smell of a water, if it has any may be brought out by heating, either gently to about 110°F. or by boiling. This may make evident a faecal odor. If $H_2S$ masks the odor it may be removed by adding a little copper sulphate. Corking the bottle and standing it away in a warm place for a few days may also develop the odor. The sediment of the water should also be examined microscopically, and for this purpose the sediment can be collected by allowing it to settle in a conical glass and then taking it

up by means of a pipette. Mineral matters are recognized by their crystalline or amorphous structure or by micro-chemical tests; vegetable cells, portions of leaves, etc., by their structure and the presence of chlorophyll; animal substances, as hair, wool, epithelial and other cells, by their special characteristics. Dark brown globular masses may come from sewage. Anything indicating that a water has come from the habitations of man renders it suspicious, as it may be contaminated by sewage. (See J.D.Macdonald's Guide to the Microscopic Examination of Drinking Water.)

To make a bacteriological examination, a small amount of the water may be mixed with a quantity of sterilized and warmed gelatine and the mass poured out on sterilized plates to harden. If these be put in sterilized chambers there will be a rapid development of colonies from the respective micro-organisms that the water contained. Or the bacteria may be colected, as suggested by Dr.Dixon, by allowing the water to flow through pieces of glass tubing containing sterilized asbestos, and then making cultures from small portions of the latter. All the necessary chemical tests for drinking water are given by Prof. Wormley and Dr. Marshall; consequently, we need only consider the value that the substances sought for in chemical analysis have in affecting potability, and within what limits we may consider these substances permissible in a drinking water. The amount of Total Solids will vary with the source of the water, but should not be over 30 parts per 100000, though more than this might be present in some cases without being harmful. Only a small portion of the total solids should be volatile and they ought to blacken but little on ignition. Even the purest waters always contain a little NaCl, but as this substance is a constant constituent of all household slops and sewage in general, water containing more than 2 or 3 parts per 100000 is suspicious and sewage contamination should be looked for, unless the water is from a source near the sea or from salt bearing strata or from very deep wells.
The presence of considerable Free Ammonia in rain water is not a bad sign, as it may have been taken up from the air, nor in deep well water; but in shallow well water the same amount of Free Ammonia, especially if with Chlorides, would indicate contamination by urine, as this latter rapidly undergoes ammoniacal putrefaction. Albuminoid Ammonia with little Free Ammonia or Chlorides generally indicates vegetable organic matter. A usable water should have but little ammonia of any kind, not over 0.15 parts per million. The simplest test for $NH_3$ is by means of Nessler's reagent, a solution of a double iodide of K and Hg. Organic matters of animal origin, as sewage, during oxidization change first into Nitrous Acid and Nitrites, and then into Nitric Acid and Nitrates. Though these are not harmful in the quantities usually found in water, and though water containing Nitrates may have been thoroughly purified by long filtration, their presence is an important aid in determining the character of the water. The presence of Nitrites is always suspicious and any marked amount of Nitrates should require close investigation. Their presence in shallow well water, together with an unduly large amount of Chlorides and Ammonia, undoubtedly indicate that sewage is soaking into the well and undergoing oxidation. Fresh sewage does not contain nitrites or nitrates. A usable water should contain no nitrite and only 3 or 4 parts per million of nitrates. Phosphates in any considerable quantity, not from phosphatic strata, help to indicate sewage contamination. So also do Sulphates, though these by themselves may come from harmless sources. The Hardness should not be over 20 grains $CaCO_3$ per 100000.

| I. | PROPERTIES: Physical; | Microscopical; | Chemical. |
|---|---|---|---|
| Pure Water. | Colorless or bluish tint; transparent, sparkling and well aerated; no sediment visible, no smell; taste palatable. | Mineral matter; vegetable endochrome; large animal forms; no organic debris. | Parts per100000 Cl,-under 1.4 Solids," 7.14 $NH_3$, " .007 N, " .023 Total hard. 8.5 |
| II. Usable Water. | Colorless or slight greenish tint; transparent, sparkling & well aerated; no suspended matter, or easily separated by coarse filtration; or subsidence; no smell; taste palatable. | Same as for Pure Water. | Cl, under 4.3 Solids, " 42.8 $NH_3$, under .015 N, " .125 Total hard. 17.3 |
| III. Suspicious Water. | Yellow, or strong green color; turbid; considerable suspended matter; no smell; but any marked taste. | Vegetable and animal forms, more or less pale or colorless; organic debris; fibres of clothing or other house refuse. | Cl, -- 4 to 7 Solids, 43 to 71 $NH_3$, .015 ".023 N, .125 to .247 Total hardness, above 17 |
| IV. Dangerous Water. | Yellow or brown color; turbid, and not easily purified by coarse filtration; large amount of suspended matter. Any marked smell or taste. | Bacteria of any kind; fungi; numerous vegetable or animal forms of low types; epithelia or other animal structures; evidence of sewage or ova of parasites, etc. | Cl, above 7.14 Solids," 71.4 $NH_3$, above .0225 N, " .026 Total hardness, -above 28.5. |

## LECTURE XIII.

Disposal of Sewage. The waste from dwellings is of three kinds; the ashes from fires and house sweepings, the waste from kitchens, scraps of food, etc., and, most important, the solid and liquid excrement from the body, together with the dirty water from wash stands, bath tubs, kitchens, laundries, etc. Ashes have little effect upon the health, except that they absorb moisture readily and if allowed to accumulate in a cellar may do much to keep it damp and mouldy. For the same reason if they be mixed with refuse vegetable matters, putrefaction is favored and noxious emanations given off: consequently they should be frequently and regularly removed from the premises. Kitchen garbage readily decays, and if allowed to remain in the vicinity of the house may cause damage, but inasmuch as it has a food value for animals, there is usually no difficulty in having it removed by scavengers without expense or delay. But the kind of waste to which we give the name sewage is of most importance to Sanitarians, being always a possible factor in the production of any existing disease and presenting the most difficulties in the question as to the proper means of its removal. In addition to the substances already named as composing it and coming from the dwelling house, sewage may contain the excreta, etc. from stables, the refuse

house,sewage may contain the excreta,etc.from stables,the refuse from factories,the drainage from polluted soils and the excess of rain water not taken up by evaporation or retained in the soil. Its composition,therefore,must be always complex,but will almost always contain in solution or suspension $NaCl$,$NH_3$,$CO_2$,$CO$,$H_2S$,$(NH_4)_2S$,foetid organic matter,bacteria,etc. Fresh sewage will not be as offensive as that in which putrefaction has commenced nor will the gases from it be as dangerous to health. The disposal of sewage concerns public interests as well as private ones,for unless properly cared for it soon affects the health of the whole community. With the ultimate disposal of it the municipal authorities will ordinarily have much more to do than the physician;but it is important that the latter be thoroughly conversant with the different methods of removing from the dwellings to the place of final disposal,and of the respective values of these methods. In this country we are not as yet compelled to make use of the excremental part of sewage as a fertilizer,though it undoubtedly has some value,and any system for removing and separating that part for that purpose from the remainder will probably not make a profitable return on the investment,though the pail- or earth-closet system may be made to partly pay expenses in that way. There are five principal systems for the disposal of sewage;viz.,1. The privy vault or cess-pool system; 2. The pail system; 3. The earth-closet system; 4. The pneumatic ,and 5. The water-carriage system. Of these,the first is by all odds the most insanitary and dangerous,and should be replaced by one of the others. Where a vault or cess-pool is insisted upon it should be made absolutely water-tight,so that none of its contents may escape to pollute the surrounding soil and to contaminate the wells in the neighborhood. The practice of using a pit till it is filled and then digging another alongside of it till the area about the dwelling is thus honey-combed with these collections of filth,and that of digging the pit in the first place to the depth of running soil-water,so that all the liquid and soluble filth may be carried off and the pit practically never fill up,should both be emphatically condemned. In both cases the surrounding soil soon becomes a mass of pollution and endangers the health of the neighborhood,not only through the use of the drinking water,but also through the medium of the soil air which may find its way into the dwellings.
Especially in villages and towns should all such cess-pools be absolutely prohibited,and in their place substituted either the water tight pits or one of the other systems. The water tight pits should be cleaned periodically,and this can be done satisfactorily and without causing unpleasant and disagrreable effects by means of some form of the odorless excavating apparatus now commonly used. But it will be better for towns to provide sewers and the water-carriage system,or if that involves too great an expense,to establish the pail- or earth-closet system. In the pail-system the faecal matter is received into a pail or tub which,holding only a limited amount,must of necessity be removed regularly and often. If the outbuilding be made so that it can be kept clean and properly ventilated the use of such a plan will be economical and healthful. But in this and the earth-closet system the house slops,wash water etc. must be kept separate from the faecal waste,which should be kept as dry as possible to lessen putrefaction and to increase its possible value as a fertilizer. Nor should the liquid house waste be allowed to flow into and pollute the soil about the house,but should either be received into a water tight reservoir,whence it can be removed at intervals,or else carried off by suitable drains

In the earth-closet system advantage is taken of the great deodorizing and oxidizing power of fine dry earth. A quantity of dry earth, in bulk about twice that of the faeces, is thrown upon the latter after using the closet, rendering them perfectly inodorous and dry. At suitable intervals the accumulations can be collected and piled in heaps without offense to any one, and after a few months the organic compounds have been so decomposed and oxidized that no trace of their former character or origin can be recognized. Ashes may be used with almost as good results, and any light, dry soil will do, though loam or clay is best and sand, gravel or chalk will not be efficient. This system is best adapted to isolated houses or small communities, where each householder can see that a proper supply of dry earth is kept on hand, but is not so advisable in large towns; in which the removal of sewage of all kinds should be under the sole supervision of proper authorities. But even in cities as large as Manchester, England, "where four-fifths of the people are obliged to have pail-closets" the pail-and earth-system is said to have proved entirely advantageous and practicable.

The pneumatic system, wherein air tight pipes run from the houses to reservoirs from which the air is periodically exhausted and the sewage thus drawn into them, would seem to be advantageous where the topographical conditions prevent natural drainage; but it is always subject to the chances of leaks occurring in the pipes and thus destroying the action. In some places, however, it is said to have acted fairly well. But where a good supply of water can be had and the necessary expense afforded, the water carriage system is best of all because it is more nearly automatic and depends less on human interference and efficiency. There are two divisions of the water-carriage system, the 'Combined' and the 'Separate' system. In the first, which has been most commonly used in this country, all kinds of sewage, including the waste liquids from factories, street washings and surplus rain water are carried off in the same conduits. In this system the area of the sewers must be sufficient to receive the greatest probable rainfall upon the area drained together with all the sewage, and consequently, the normal daily flow of sewage is so sluggish as to favor the settling of the solid constituents, the clogging of the sewrs and the development of bacteria and sewergas. To obviate this and to keep the depth of sewage in the sewers as great as possible and thus insure a more rapid flow, the sewers are now made egg-shaped in section with the smaller end downwards. But in dry weather care must be had to flush the sewers often, else they become very offensive and endanger the health of those into whose houses gases from them may gain access. Moreover, the large size necessary to take in the possible rain fall makes them much more expensive to construct and to keep in repair and greater care must be taken to see that they are at all times properly ventilated. The advantage of this system is that the expense of building separate conduits to carry off factory wastes, street washings and rain water is avoided, but this is a doubtful one, both as to economy and health.

In the separate system, only the sewage proper from houses and occasionally from small factories is admitted to the sewers, the rain, surface and soil waters being removed by other conduits. The advantages of this system, which is now endorsed by almost all sanitarians, are that the volume of sewage to be carried is small, comparatively constant, and that it can be calculated very approximately from the water supply and population; that the cost of this is much less than that of the combined, and that while it can be used in the largest cities, it is the only one that small communities can afford

that the sewage is uniform in composition and can thus be better utilized, if desirable, as a fertilizer, and that the sewers are more frequently and effectually flushed as they are small and have even walls. Such sewers are also more completely ventilated and altogether better suited to the work to be performed. The disadvantage of the separate system is that every house must have two sets of drains, one for sewage and the other for rain water, and that after a long dry season the rain water and street washings are very foul, but the advantages greatly outweigh this. "No sewer in this system should be more than 6 inches in diameter until it and its branches have accumulated a sufficient flow at the hour of greatest use to fill this size half full, because the use of a larger size is wasteful and because ventilation becomes less complete as the size increases. The size should be increased gradually, and only so rapidly as is necessary by the filling of the sewer half full at the hour of greatest flow; and the upper end of each branch sewer should be provided with a flush tank of sufficient capacity to secure the thorough daily cleansing of so much of the conduit as from its limited flow is liable to deposit solid matters by the way." All sewers should be laid on a good foundation with sufficient fall to give at least a velocity of 2 ft. per second to the flow. If made of bricks they should be laid in a mortar made of cement and sharp sand, and all sewers should be as smooth as possible inside to prevent the arrest of particles of sewage. Sewers of the combined system should not be pervious to the soil water, as the liquid sewage is as apt to pass from them into the soil in some cases and pollute it dangerously as the soil water is to pass into the sewers. But ground water drains may sometimes be laid in the same trench with the sewers, and in the separate system the conduits used to carry off the rain and surface water may also be employed to drain the subsoil.

## LECTURE XIV.

PLUMBING and HOUSE-DRAINAGE. The soil-pipe is that pipe in our houses which receives the sewage from water closets and other fixtures and which connects them with the house-drain. The house-drain is the conduit connecting the soil-pipe with the sewer or cess-pool. The soil-pipe should be almost entirely within the house; the house-drain should be entirely outside the house, or else easily accessible wherever it must be within the house. The soil-pipe should be at least four inches in diameter and must extend unobstructed from the house-drain to above the highest point of the roof, and should be placed where winds and currents from chimneys or higher walls will not interfere with its free ventilation. It should be of uniform size throughout and not contracted at the top. All joints must be perfectly tight and the pipe must be secured so that any settling of the building will not be likely to destroy its continuity. It must be smooth internally to prevent obstructions and clogging. Branches from it must be of full size and carried through the roof. There must be no dead ends to this pipe for the collection of foul air. Its connection with the nearly horizontal house-drain should be by a rounded elbow; not at a sharp or right angle. But if necessary, it may be carried at a slope along the cellar wall securely fastened there-to to meet the house-drain. In this country the soil-pipe is usually of cast or wrought iron.

The house-drain may be of iron or of glazed and impervious earthen-ware. It should be laid on a hard foundation with a good slope to the sewer or cess-pool. If it empty into a cess-pool or sewer of the combined system, almost all authorities direct that there be a

trap just before its junction with the sewer or ~~cess-pool to pre-~~
vent the passage of sewer air into the house; but Prof. Rohé dissents from this and thinks that better ventilation wil be had by leaving the entrance to the sewer free. This seems to me dangerous, as the sewer air may at any time contain the germs of specific diseases. There should be an opening for fresh air between this trap and the foot of the soil-pipe, and this is usually just inside the trap at the end of the drain. There will then be almost constantly a current of air through this opening and up through the drain and soil-pipe to the exit above the roof, thus keeping the air in the soil-pipefrom becoming foul and stagnant. But if the house-drain empties into a sewer of the separate system, there should be no trap between the drain and sewer, as this is one of the means by which the sewer is ventilated; the fresh air inlet is, however, advisable, as it tends to further assist the ventilation. All rain water conductors emptying into eithr house-drains or sewers should be trapped to prevent sewer air passing up through them to the vicinity of upper windows.

In the house all water closets and other fixtures should be as near the soil-pipe as possible, that there may be no long stretches of foul waste pipe underneath the floors, and all connections with the soil-pipe should be made at an acute angle, that the discharge into the latter may not interfere with its free ventilation. Each fixture must be separately trapped, and the trap must be located as near its fixture as possible. There must be no connection between a fixture and the soil-pipe which is not trapped.

TRAPS. Most traps are too complicated. The simpler a trap, the better, provided it have sufficient seal. Mechanical appliances are liable to become clogged, not to fit tightly and thus to allow the passage of sewer air. The S trap is as simple as any, is of uniform diameter throughout, has no corners or projections to catch dirt, and is thoroughly cleansed by each fair flow of water through it. The value of a trap does not depend so much on the amount of water it contains as on the depth of seal. On account of evaporation the water seal of a trap soon becomes lessened or destroyed unless its fixture be in frequent use; so it is therefore advisable to have as few fixtures of any kind in the house as the comfort or convenience of the inmates will allow. Also, if a house is to be left unoccupied for a time, it is well to cover the water in the traps with oil or glycerine to prevent the evaporation. The seal of a trap may also be broken by siphonage, either by a rush of water through it from its own fixture or by a rush down the soil-pipe from a fixture higher up, and this is especially liable to occur if the trap be some distance from the soil-pipe. To prevent this openings are sometimes made at the top of the traps and connected with vent pipes which should open into the soil-pipe above the entrance of the waste-pipe from the highest fixture. But this greatly increases the expense, as the vent pipes to be efficient must be almost 2 inches in diameter, and also favors evaporation from the trap. If the trap is properly constructed, the soil-pipe of proper size and height and if the fixture be placed as near the soil-pipe as possible, there will be but little danger of siphonage occurring. Where it does occur McClelland's anti-siphon attachment is said to work advantageously, being inexpensive and permitting a free ingress of air to the trap. It is also said that if the fixture be connected to the soil-pipe by a divergent opening siphonage will be less likely to occur.
Absorption of gases by the water in the traps and the subsequent dispersion of them into the air of the house is almost absolutely impossible if the foregoing cautions be observed, as the air in the

soil-pipe will be almost as pure as that of the house itself. There must be an inlet and outlet to the soil-pipe,and free communication between these,else the air cannot be changed and foul gases will accumulate. In such a system we have for our object;"I. The speediest possible removal from the house to the public sewer of excretal and other refuse by means of water. 2. The prevention of deposit of foul matter in any part of the drainage system,and of percolation into the soil of polluting liquids. 3. The establishment of a current of air through every part of the soil drains and pipes,in order to disperse any foul gases that may form,and to allow them to escape with safety into the open air. 4. The prevention of any entry of air from soil-pipes,drains and waste-pipes into the house. 5. The exclusion of the air of the common sewer from the house-drains and the house;the last being,perhaps,the most important,as the air of the public sewer may at any time contain the active germs of specific disease." House drains should never empty into a cess-pool,nor should cess-pools be allowed to empty into a public sewer,because of the dangerous nature of the contents and the gases from cess-pools. All soil-pipes and house-drains should be tested before use. Leaks may be detected by plugging the lower openings and filling the pipes with water,or by pouring an ounce of oil of peppermint into the highest fixture and quickly following this with several gallons of hot water,the heat volatilizing the oil,whose odor escapes at every opening in the pipes unprotected by a trap or water seal. The heat imparted by the hot water will also help to trace out hidden soil-pipes. All pipes placed in new buildings should be as accessible as possible,however,or else made of extra heavy materials and with extra care as to joints and supports.

All fixtures should be exposed to the free ventilation of air underneath and about them,and water closets and wash-stands should not be closed in with carpentry work. Traps should also,if possible. be where they may be opened and inspected at any time. Under each fixture there should be a drip-safe or tray to catch any leakage or overflow of water,but the pipes leading from these should never empty into waste- or soil-pipes:they should lead preferably to the open air,and not to the cellar,as the air in most cellars is bad and thus gains access to the house. Even if trapped and opening into the soil-pipe,the water in the trap is replenished so rarely that evaporation soon destroys the seal and allows the air to pass from the soil-pipe into the house. The overflow pipe of old-fashioned wash-stands and bath tubs is objectionable,as it collectsdirt of all kinds,soap,epithelium,etc. and it is almost impossible to clean it. Besides,it will often be found opening into the waste-pipe below the trap,allowing the free passage of sewer-air into the room. Where new fixtures are being put in they should,preferably,be such as make use of the stand-pipe principle,and that have no separate overflow pipe or outlet.

## LECTURE XV.

The requisites for a good water-closet are: That it should not allow the esgape of sewer air from the soil-pipes into the house; that it shall be thoroughly and easily cleaned each time after use; that there shall be no hidden parts in which filth can collect,or which cannot be readily cleaned; that the flushing or washing out of a closet be done in such a way that dirt or spray be not thrown into the air of the room; that there be sufficient water supply to wash out the bowl and trap each time and to refill them to the proper level; that the trap itself is not siphoned or left empty by a discharge of water from this or another fixture.

Of the different kinds of water closets the pan and the valve-closets are the oldest and the worst, and should not be used. They consist of a receiving bowl, the bottom of which opens into a swinging pan or is closed by a valve. The pan or valve and the lower part of the receiving bowl are enclosed in a larger bowl, the container, connected with the soil-pipe and trap. The dpth of water in the receiving bowl is regulated by the depth of the pan in pan closets, and in valve closets by the location of an overflow outlet. In both kinds the contents of the receiving bowl are discharged into the container by the tipping of the pan or valve, and the consequence is that the sides of the container as well as the under side of the pan or valve soon becomes thickly coated with filth. This, being hidden, accumulates, decomposes and contaminates the air in the container, which air is of necessity discharged into the room as it is displaced by the contents of the receiving bowl. In the valve-closets the overflow pipe from the receiver furnishes an additional way by which the foul air may pass from the container into the atmosphere of the room. It needs no argument to show that these closets are decidedly dangerous to health. Plug or plunger closets are those in which the outlet above the trap is stoppered by a plunger, this being usually in a chamber at the side of the receiving bowl. The bowl and side chamber holding a considerable quantity of water, the trap is well flushed out each time of use; but the side chamber and plunger being hidden and not easily cleaned, soon become coated with filth and dangerous to health, as there is nothing to prevent the air from passing from this chamber into the room. Moreover the plug may not close the opening completely, thus allowing a continual waste of water. A trapped overflow pipe in the plunger keeps the closet from being filled too full and overflowing. Hopper closets consist simply of a bowl connected below with an ordinary trap, and as there is nothing to get out of order, this kind is one of the best. The objection to long hoppers is that dirt is apt to stick to the sides and become offensive, but this can be prevented if it is so arranged that water begins to flow down the sides as soon as the closet is put in use, thus preventing adhesion. Short hoppers have not this objection, as the faeces fall directly into the water in the bowl and are carried out through the trap as the bowl is flushed. All water closets should have a flushing rim encircling the top, so that all sides of the bowl may be washed down and cleansed each time the closet is used. Wash-out closets retain considerable water in the bowl and are emptied by a strong flush of water from the flushing rim. They are simple, do not readily get out of order, and are much in favor at the present time. As they are a modification of the short-hopper closet, so is the siphon closet a modification of the wash-out. In the siphon closets the contents of the bowl and trap are lifted out by a siphonic action, and then the bowl and trap refilled, as in the case of wash-out closets, by an after flush. In the Dececo closet, a siphon closet, use is made of the principle involved in the Field flush tank. Hopper, wash-out and siphon closets should be supplied from water closet cisterns, which should give down a certain and sufficient volume of water with only a short pull on the chain. The bowl and trap should also be refilled from the cistern after use. Water closets should not be connected directly to the water supply pipes of the house, as air from the closets may be sucked into them at times when the water supply is cut off, and the water afterwards be contaminated by it. But this is hard to avoid in pan, valve or plug closets, and is another serious objection to their use. Vent pipes from the bowl and seat of water closets must be large, must not open into the soil-pipe but into the

open air; they must not open near a window nor any opening by which air is taken into the house, but may open into a flue which is constantly heated, as the kitchen chimney, or they may be heated and a current kept up by a small lamp or gas-jet. No water closet should be palaced in a living- or bed-room.
Water closets should always be in rooms that have free communication with the open air, either by means of a large window or a ventilating shaft of at least four square feet area. Urinals, if used, must be constantly and freely flushed, else they soon become offensive. The floor of urinals should be of slate, porcelain or enameled iron.

BATHING. In health we make use of baths and bathing for the cleansing of the body, the stimulation of the functions of the skin, and to furnish a tonic to the whole system. A proper bath properly taken is exhilarating and thoroughly enjoyable. Baths are also to be employed in sickness as a means of cure; but such use of them is foreign to the present discussion. Dr. Wood says; "Cleanliness and the maintenance of the proper condition of the skin require the use of the bath at least twice a week. In some very delicate persons the general bath produces marked depression, but this can almost always be avoided by the use of very hot water. If the hot or warm bath be employed habitually, it should be preferably taken at night, and, unless under very exceptional circumstances, the hot bath should always be followed by cold sponging or the cold shower bath, or by a plunge into cold water." The temperature of a cold bath may be from 40° to 75° or 80°F., that of a tepid bath, 75° to 85° or 90°, a warm one, 85° to 100°, a hot one, from 100° to 110° or even hotter.
A cold bath is taken, not so much for its cleansing as for its tonic and stimulating effects; the others are used mainly for their cleansing properties, though if followed by the cold sponge, shower or dip, the sense of exhilaration produced will be marked. Cold baths taken immediately after physical exercise, while the body is still warm, but after perspiration has ceased, and followed by good rubbing and friction of the skin, dispel fatigue and give a sense of buoyancy and lightness. The shock of the first contact of the skin is but momentary and can be withstood by most persons, unless there be serious organic disease, and the reaction produced certainly compensates for the momentary discomfort. If the bath be taken in the open air, there is the additional benefit of a plentiful supply of fresh air for the lungs, of the physical exercise and increased circulation induced by swimming or combatting the surf, and, if in the sea, of the stimulation of the skin by the salt. In fact, sea-bathing may be advantageous to a marked degree where the circulation and action of the skin is sluggish. Or a sea-bath can be imitated at home by adding about one pound of salt to the gallon of water. Those who are subject to organic heart disease should not indulge in sea-bathing, nor in deep fresh water bathing, where a sudden tax may be made upon the strength and the heart action be disturbed or checked. Women who are menstruating, or who are in the later months of pregnancy, should not take cold baths. Baths should not be taken too soon after meals, because digestion may be lessened or entirely stopped by the blood being called from the stomach to the skin and muscles, and nausea and vomiting thus induced. Rohé says: "There can be no doubt that many of the cases that are called 'cramps', and which frequently result in drowning, are due to this cause." In cold baths the head should be immersed first, to avoid increasing the blood-pressure in the brain too greatly, which might result if the body be were gradually immersed from the feet upwards."

The following rules issued by the English Royal Humane Society are worth noting. "Avoid bathing within two hours after a meal, or when exhausted by fatigue or any other cause, or when the body is cooling after perspiration(?). Avoid bathing altogether in the open air, if, after having been a short time in the water, there is a sense of chilliness, with numbness of the hands and feet; but bathe when the body is warm, provided no time is lost in getting into the water. Avoid chilling the body by sitting or standing undressed on the banks or in boats, after having been in the water. Avoid remaining too long in the water, but leave the water immediately if there is the slightest feeling of chilliness. The vigorous and strong may bathe early in the morning on an empty stomach: the young and those who are weak had better bathe two or three hours after a meal; the best time for such is two or three hours after breakfast. Those who are subject to giddiness or fainting, or suffer from palpitation or other sense of discomfort at the heart, should not bathe (out of doors) without first consulting their physician." Vide Sea-Air and Sea-Bathing, by Dr. John H. Packard.

After any kind of a bath the body should be thoroughly dried, not only to restore and accelerate the circulation of the skin by the friction and to prevent the cooling by the evaporation of the water but also to prevent chafing and eczematous eruptions where the skin is subject to friction of clothing. Warm or hot baths should not be taken if the person is to be exposed to the cold within several hours, and the same rule applies to Turkish, Russian and vapor baths. So these latter should not be taken away from home in cold weather, unless the bather takes pains to rest well after the bath, and then to cool well before going into the open air. In all warm baths in health the principal object is to secure the cleansing effects, and to be effective their use must be systematic. The pores of the skin are self-cleansing only to a certain degree, and the free use of warm water is most beneficial in removing dry epithelium, sweat, dirt and grease. If the pores of the skin are obstructed there is not only irritation and eruptions of the skin produced, but more work is thrown upon the kidneys and these, if affected, will break down the quicker. Soft water is to be preferred for ordinary bathing and washing because it often prevents or reduces cutaneous irritation, and because it saves soap.

A Turkish bath consists 1. In a dry, hot air bath at a temperature of from 120° to 170°F., or even higher, from ten to thirty minutes. This causes in most persons extreme perspiration, with no sense of discomfort, but rather a very pleasant sensation. After this comes 2. A hot shower bath to wash off the sweat; 3. Shampooing, massage and scrubbing, to thoroughly remove all dirt, loose epithelium and perspiration from the skin. This is in moist hot air at from 100° to 110°F. 4. A warm showerbath gradually changing to a cold one, and then a thorough drying of the body and a rest for a quarter or half an hour. A Russian bath differs from this only in that moist air at 150° or less is used instead of dry air for the first bath.
It has been said "that a person ought never to stay in either the hot air or steam room, if in any wise oppressed, or to use very cold water afterwards, if one feels any shrinking from it." Nor should one who is very corpulent, or subject to organic heart disease, take a Turkish or Russian bath without the advice of a physician. But for healthy persons they are very pleasant, and in most cases beneficial, provided they are not taken too often, and that one does not indulge in them too long at a time.

The terms sun-, mud-, sand-, and pine needle-baths are self explanatory. These are used in treating certain diseases and are supposed to do some good, especially in rheumatic affections.

SCHOOL HYGIENE. This subject is of importance to the physician, not only because he is often called to act upon school committees and boards of education, but mainly because many of the disturbances of health in childhood which he has to treat have their origin or cause in the harmful and insanitary conditions of school life. We will consider especially the Personal Hygiene of the scholar; the condition of his health, his habits, and the amount of work done, and the influence of these on his future state and development. As to the sanitary requirements of school-rooms and buildings, the External Hygiene, the principles already laid down in the notes on ventilation, heating, drainage, etc. apply equally well here, but a few special points will be noted, as notably applicable to school-buildings.

There are disturbances to which all children are subject, whether in school or out; but a special class are markedly influenced by school-life and work, and to these we may give the term, -School Pathology. Of some of these overwork is the cause; others are set up by other conditions. Overwork, coupled with depressed vitality may give rise in children to one or more of the following; Dyspepsia, headaches, nervous derangements, chorea, epilepsy, neurasthenia, back-aches, menstrual disorders, and in some cases, consumption. On the other hand, bad arrangement of seats and desks, improper location of windows, blackboards, etc. may cause spinal and other physical deformities, defective eyesight, etc. Of the first class, even where the amount of work may not seem or may not really be too much for the capacity of the child, worry about rank or over an approaching examination may have a harmful effect upon a nervous temperament. Thisis especially so when the examinations come at the end of a spring term, when the scholars are all more or less worn out and debilitated. The forcing process should be avoided as far as possible, and if grades are to be given at all, they should be as much as possible for the work and attendance during the term, and not so much for the actual work done at examination time. Moreover, young children should not be kept in school for too many hours in the day, nor should the school be looked upon by parents as a place to which to send children to keep them out of the way and from mischief. Edwin Chadwick has shown that a child from five to seven years can only attend to one subject for about fifteen minutes; one from seven to ten, for twenty minutes; from ten to twelve, for twenty-five minutes, etc., and that the length of individual lessons, and likewise the total day's work, arranged accordingly. The very early years of school-life should be given to inculcating correct habits of attention and of morals and to training the will and power of concentration, rather than to the teaching of any special knowledge. But it is probably the work attempted outside after school-hours, and not the actual work done in the school that is most responsible for the breaking down of health, especially in older scholars. In Cleveland in '81 of 186 girls in the High School, 29% of those who studied less than 2 hrs. out of school had poorer health while at school, 70% of those who studied from 2 to 4 hrs. daily out of school, 93% of those studying from 4 to 6 hrs. outside, and 100% of those studying over 6 hrs. out of school. Of these same girls, the percentages of those whose health was "very poor while at school", dividing them the same way as regards overwork, were respectively 14%, 40%, 66% and 100%. This loss of health was attributed by the parents to stair-climbing, irregularity of meals, worry about rank and examinations, etc.; but Dr. Goodell says; "So commonly do I find ill-health associated with brilliant scholarship, that one of the first questions I put to a young lady seeking my advice is, 'Did you stand high at school?'"

"The effects of anxiety are worse than carrying heavy loads." While a child is at school its mind should not be wearied by out side tasks, as music or painting lessons, nor the body weakened by social dissipations, late hours and indigestible foods. Girls are more susceptible to disturbances and are more subject to them, because they are more willing to undertake extra or double work than boys, and because they are more ambitious and worry more about rank. In all children the obtaining of good health and a sound constitution is of the first importance. Youth is the time for gaining health, not for losing it; for building up sound bodies and constitutions, not for breaking them down, and school-life should always have that as one of its greatest ends. Of what use is all the learning one may gain before the age of eighteen, if there be no strength to use it afterwards in the battle of life?

School-life is sometimes responsible for dyspepsia by interfering with the regularity of meals, the children missing the mid-day meal and having to depend upon a meagre lunch, often of sweet and indigestible food. This is especially important when the rest of the family dine at noon and there is only a light meal served in the evening. Again, many habitually lose their breakfast through fear of being late, or else bolt the food without masticating it and gulp down hot coffee or tea before starting on a run for school. But often the loss of appetite is due simply to lack of fresh air and proper exercise. Such dyspepsias are to be treated by attention to the foregoing points rather than by medicine.

Headache is acommon disturbance among school children, and may be due to any one of several causes, among which are over-work, producing irritability and disturbances of cerebral circulation, bad air, eye-strain, etc. The eyes should always be examined when headaches are persistent, and defects corrected by proper glasses. With headaches nose-bleed may be a symptom and should not be overlooked, as it may indicate circulatory disturbance. One of the most common symptoms of nervous derangement is sleeplessness or restless sleep, and this condition should give warning that something is wrong. Dr. Folsom says; "I doubt whether there is an exaggerated prevalence of manifest or well-marked diseases of the nervous system among school-children. If due to the school-drill, my impression is that they come for the most part later in life, after the children have left school, and because of constitutions weakened during the school years, instead of strengthened as they should be." Children subject to chorea or epilepsy should not attend school, not only for their own sake, but for that of the other children, who may be unduly affected by their nervous manifestations. They should be educated quietly and cautiously, with proper treatment and plenty of out-door life. Neurasthenia, or general breakdown, may occur, usually from over work and especially among young women. It may come on unexpectedly after the examinations, when the strain and excitement is removed. Menstrual disorders are also apt to occur among girls that are being over-worked mentally, and we ought to remember that at the time this function is developing the system is undergoing a heavy strain. Also, to certain women rest from customary work is necessary at the time of the periodical recurrence, and excuses for absence at this time ought to be freely granted. It has been said that "girls get through as much work as boys, working in their own way."

The development of consumption may be due to the school-life, tho' it is hard to say how frequently this is the case. Bad air and over work are both important factors in its production, and if these are forced on underfed or predisposed children the disease may be provoked.

"In a consumptive family the steadfast rule should be, that the mind be wholly subservient to the body's welfare."

The main cause of spinal and other deformities and defective eyesight is apt to be found in faulty construction of seats and desks, improper location of windows, etc., though excessive work or strain may maintain a low vitality and act as predisposing conditions. The latter point is shown by the fact that spinal curvatures are more prevalent in those especially prone to weakness of the muscles, as girls and women. But no seat or desk will remove original weakness of muscle as the one important predisposing condition, and children cannot be made strong by supports. "Spinal curvature is not only a product of low vitality, but does harm by permanently fixing vitality at a low standard." Bad seats and desks not only cause spinal deformities, but help to cause defective eyesight by making the scholar hold the book too near the eyes, and by making him bend his head so that the circulation of blood is impeded and ocular congestion favored. However, no seat can be devised in which a child will maintain a correct or "normal' position for any length of time, as this is an impossibility for young children, but the true aim should be to furnish a seat in which one will naturally assume the correct position after having temporarily taken any other. "Movement is a child's way of resting; rest is a kind of work, to be taught by degrees." Seats should have backs to prevent fatigue, but a comfortable back gives support to the lower part of the spine rather than to the shoulders and upper part of the spine. Many foreign authorities advise seats with backs only high enough to support the lower part of the spine, and low enough for the scholar to rest his elbows upon them while studying. The following points, suggested by Dr. Lincoln, are worth noting: 1. The chair is often too high for young scholars. The most convenient plan may be to provide foot stools. 2. The seat from back to front ought to be long enough to support nearly the whole thigh. A more or less spoon-shaped hollow in the seat is commonly thought desirable. The curve of many settees is such as to produce pain at the point where the tuberosities of the ischium rest on the wood; the support is not wide enough. 3. Seats must have backs. The straight upright back reaching to the shoulders is bad; a straight back, slightly tilted is not bad. American seats are commonly curved, with curved backs. 4. The edge of the desk should come up to, or overlap, the edge of the seat. The recognition of this fact is a recent discovery. 5. Most of our best desks are too high relatively to the seat, doubtless to prevent the pupil from stooping. Something is gained in convenience of reading by this plan, but it interferes with correct positions in writing. The elbows, hanging freely, should be only just below the level of the lid." For near-sighted children the higher desk may be a necessity in writing: if the desk is made low a portable writing stand may be placed on top of it when necessary.

Windows on only one side of a large school-room may not give sufficient light upon the desks most remote from them. Consequently, there should be windows on two sides, preferably adjoining ones, of large school-rooms. The windows should be at the back of and to the left of the scholar, thus giving the best light upon the desk either for reading or writing. They should not be placed in front of the scholars, as the continuous light and glare is very trying and injurious to the eyes. They should extend almost to the ceiling and have square tops to admit as much light as possible. Blackboards should have a dead black surface, not a glossy one, and should be on the sides of the room on which there are no windows.

Walls should be of a neutral tint, not glaring white.

Construction of School-houses. The principles already given as to ventilation, heating, water-supply, etc., apply here as elsewhere. From 1800 to 2500 cu.ft. of fresh air should be supplied to each scholar per hour. In cold weather this should, of course, be at least partially heated. The air-ducts, both inlets and outlets, must be large enough to change the air without causing injurious and uncomfortable draughts; and these ducts should be as short and free from bends as possible, or better, the rooms should open into the supply and exhaust shafts directly. The air may be pre-heated either by steam or hot water coils or by a furnace, though preferably by the former to avoid 'baking' the air, and also preferably by the indirect system. There is no objection to having additional heating apparatus in the school-rooms, provided it is guarded so that the scholars may not be accidentally burned. Any system that will give a sufficient supply of fresh air properly heated will of necessity be more expensive than the old way of not ventilating at all except by opening the windows at recess time, but experience shows that the increase in expense is not so very great, as so much heat is lost by opening the windows in this way, and the benefit to the children fully compensates for the increase. The school-house should be on dry and well-drained soil, as dampness is not only depressing to all constitutions, but is an important factor in the causation of phthisis. There should not be too much shade about, and as many rooms as possible should have sunny exposures. If the sun is annoying during the session, it may be excluded by inside blinds or shutters, but we must not lose sight of its helpful influence in the oxidation of organic matters. Basements of school-houses should be well-lighted, water-tight and dry, and should be kept scrupulously clean, that moisture and noxious gases may not be drawn into the rooms above.

Country schools may be heated by stoves surrounded by sheet iron drums, and with fresh air brought in from without near the bottom of the stove. Passing up between the stove and drum, it gives good ventilation without chilling or draught. As great a length of stove-pipe should be exposed as possible, to get the benefit of the heat from it. The water supply should be free from all impurities and as good as can be had. In the country, if from neighboring farm-house well it may be contaminated by leakage from cess-pools and barn-yards. For this reason teachers should be taught to make the test for chlorides and the reason for it, and should make this test frequently. If cause for suspicion arises the use of the water should be stopped at once. Water-closets and urinals, where in use, should be kept clean by a competent janitor, and the principal or head should see that this is done. In the country the pail- or earth-closet system should be substituted for the old privy-vault or cess-pool, and it should be the duty of some one apart from the teacher, regularly appointed and paid by the school-directors of the district, to see that removals are made at proper intervals; the teacher should maintain supervision over the daily condition of affairs. If possible, the out-houses should be connected with the school-house by covered ways, that the children may not be exposed in inclement weather, but these ways should be open or else constantly ventilated by open windows on either side. Cess-pools should be at least 50 ft. distant, and should drain away from the school-house.

Ample provision must be made for the rapid escape and for the safety of scholars and teachers in case of fire or panic. Fire-drills should be regularly practised in all schools of two stories or more, and presence of mind inculcated, that emergencies may be met with safety. The comfort of the child should not be forgotten in the construction of the school-house, though health is the main aim.

School Quarantine. As certain diseases are contagious, it is necessary that school-authorities have the right to forbid the attendance of such persons as have been exposed to infection until all danger of transmitting the disease to others is passed. This power is usually, however, exerted only in the case of those diseases most dangerous to life and health, though the stringency of the regulations differs at different places. Small-pox, scarlet-fever, diphtheria, measles and even whooping cough ought always to be quarantined, and it would be better to keep children out of school who are afflicted with minor diseases of this class till all danger of infection is over, as it is only by rigid measures like this that we may finally be able to wipe these maladies out of existence.

Local Boards of Health should make and enforce rules looking to the prevention of the spread of the graver contagious diseases, and should, when necessary, close schools and school-buildings till all danger is past. Dr. Lincoln gives the following as a system of general regulations: "I. Persons affected with diphtheria, measles, scarlet-fever, or small-pox, (varioloid,) must be excluded from the schools until official permission is given by the Board of Health for their readmission. 2. Persons living in a family or house where such a case occurs are also excluded until similar permission is given. 3. This permission is not to be given until sufficient time has elapsed since the occurrence of the last case to insure safety, nor until the premises have been disinfected under the direction of the Board of Health. 4. If a child suffering from one of the above diseases attends school, the premises of the school must be disinfected under the direction of the Board of Health before they are used again. 5. physicians, teachers, school-officers and school-children, knowing of such cases of disease should at once report them to the Board of Health. 6. The Board should also notify the school-authorities of all such cases. 7. Notice must be sent to the family by the school-authorities, acting conjointly with the Board of Health.

Children having had one of the above diseases, may return to school with safety after the following periods: "Scarlet- fever; six weeks from date of rash, provided desquamation have completely ceased and there be no appearance of sore-throat. Measles; three weeks, provided desquamation and cough have ceased. Small-pox and chicken-pox; when every scab has fallen. Whooping-cough; after six weeks from commencement of whooping, provided the characteristic spasmodic cough and whooping have ceased, or earlier if all cough have passed away. Diphtheria; not less than three weeks, when convalescence is completed, -there being no longer any form of sore-throat nor any kind of discharge from the throat, nose, eyes, ears, etc., nor any albuminuria." Rules and regulations like the above, when promulgated, "should have the force and authority of law, and should be enforced, if necessary, by the entire power, including school-officers, etc., of the State." It is to be hoped that we shall soon have a means of inoculating persons against all contagious diseases, as we now do against small-pox. At present, Boards of Health and school-boards should insist on the vaccination of all school children. In Illinois from 1880 to 1883 the deaths from small-pox among unvaccinated children were 48%; among the vaccinated, only 0.9%. In this city all who desire it are vaccinated free of charge by the vaccine physicians, though it is not compulsory. Regulations similar to the following, suggested by Lincoln, should be in force in every school-district. "Every child entering the public schools must show a certificate from some reputable physician, giving name, age, residence, approximate date of vaccination, date of examination, result of examination; the last two to be of the physician's own knowledge. The fact

of vaccination must be entered on the school-record,and on lists for promotion and transfer. The school-authorities shall annually report the number of those not protected to the State Superintendent of Education. School-authorities may order the exclusion of non-protected persons,after sufficient notice,where they think the measure required for public health. Revaccination at the age of fifteen may be required under similar circumstances. Those unable to pay should be furnished with free vaccination by the school-authorities. A physician's certificate of protection by a previous attack of small-pox is equivalent to a certificate of vaccination."

Contagious ophthalmia is a disease often prevalent in institutions and occasionally in primary schools,and requires great care to prevent its invasion and spreading as well as to effect a cure. Those afflicted with it should be quarantined until there is no further discharge or till the granulations on the inner surface of the eyelids have disappeared. Enfeebled health and poor and insufficient food favor its development,but the chief means of contagion is by the use of the same wash basins and towels by a number of children.

School-children should not be allowed to attend the funerals of companions dead of a contagious disease,nor should funerals be allowed in school-houses under any circumstances,owing to the effect on the thoughts and sensibilities of nervous children.

Boarding schools and institutions should have an infirmary where contagious diseases may be isolated,and should make that isolation as complete as possible from other scholars and inmates. At the beginning of a term it may be well to subject any who have been exposed to contagion to a delay till the probable period of incubation for the special disease is passed,the period dating from the time of exposure. With the above precautions it will rarely be necessary to close a school,unless a disease be markedly epidemic and malignant.

Prophylaxis. Diseases are divided into two main classes,considerably different in their origin,nature and character. The first arise within the body through some alteration or disturbance of nutrition and assimilation,and are called Autogenetic:their causes do not come from without,though there may be external predisposing or aggravating conditions. The second class comprises those which are due to a cause from without,favored it may be by either external or internal predisposing conditions,but of necessity depending on the reception or inoculation of the special cause,which cause has the power of reproduction and development,of vitality and virulence. Such diseases are called Contagious,Infectious,Specific or Zymotic. Prophylaxis is "the use of hygienic or other precautions conducive to the prevention of disease";or it may be defined as "a series of methods or procedures whereby disease is restricted and prevented by suppressing or removing its predisposing conditions,and destroying or modifying the exciting causes."Its first function of suppressing or removing predisposing conditions is accomplished by Sanitation;the second,that of destroying or modifying exciting causes,is carried out by Disinfection. The words'predisposing conditions' instead of 'predisposing causes'should be used,because these conditions can never in themselves originate a disease,though they may make the system more susceptible to the exciting cause of a disease.

As we have,as yet,very little definite knowledge of the real nature of the exciting causes of autogenetic diseases,they being developed and elaborated within the body;and as disinfection,or the destruction or modification of these exciting causes,is an essential feature of prophylaxis,we are compelled as yet to apply prophylaxis mainly to the contagious diseases,the causes of which are

demonstrable without the body. This does not restrict the use of prophylaxis and sanitation,however,in autogenetic diseases by the selection of proper diet,clothing,climate,etc.,but indicates that at present the most fruitful field for prophylaxis is among the diseases of the second class. Sanitation is the defensive,disinfection the aggressive part of prophylaxis.

Sanitation. To remove and suppress predisposing conditions,and to prepare the body to resist and repel the action of exciting causes,we must not only strengthen its resisting powers but make all external media as favorable to it and as hostile to the exciting causes as possible. The resistant powers of the body must lie in the individual cells of the body,and it is but natural to suppose that this repellant action to noxious substances is best performed when the cells are in most perfect health and most vigorous. We have also learned that purity of the external media,as air,water,etc.,is essential to the health of the body and its component cells,and that conditions of impurity in these media predispose to disease. We shall also learn that a proper and sufficient supply of wholesome food is essential to health,and that certain other factors,as sex,age,clothing,climate,etc.,may or may not predispose to disease. In other words,if we strengthen the resisting powers of the system to the fullest extent and remove all predisposing conditions,in all probability the exciting causes will be inoperative and there can be no incurrence of the disease. This is the essence of sanitation, to secure perfect health,to increase the inherent power to resist noxious and harmful influences,and to make all the surroundings and environments of the body pure and free from depressing factors. This applies equally to both classes of disease;for with healthy cells and proper food there will not be faulty nutrition and assimilation,and the consequent production of the exciting causes of autogenetic diseases;and by vigorous resistance and pure surroundings there is little hope of the germs of the contagious maladies gaining a foothold within the system long enough to reproduce themselves and cause the disease. The best means of preventing disease is to learn and apply the best means of attaining and retaining a healthy and vigorous state of the system:to observe the Laws of Hygiene.

## LECTURE XVIII.

Bacteriology. Before going on to discuss Disinfection,it will be well for us to consider briefly the nature of those exciting causes of contagious disease which disinfection aims to destroy or modify, and,if possible, the means by which they do their harm.

Bacteriology is the Science of Micro-organisms;and its study consists in the study of these Micro-organisms and their form by the microscope,in their artificial cultivation on suitable culture-media,and in the study of the effects of the pure cultures upon animals., All these micro-organisms,or microbes,as some call them,we classify under the generic term Bacteria,though the name Bacterium is also given to one of the minor species or divisions.

If we divide them according to their form,according to Macé,we have three families;the Coccacees,which are normally spherical in shape considering their individual elements;the Bacteriacees,whose elements are rod-shaped,either in short cylinders or filaments,but whose length always exceeds the breadth;and the Beggiatoacees,whose elements are rods or filaments,but with a base,often fixed,and with a free apex or top. Under the first class come the micrococci and

sarcinae,under the second,the bacilli and spirilli,and under the third,the beggiatoa. Another way of classifying them is by the kind of work they do,the substances they produce or the effects of their inoculation upon the animal organism. Accordingly,we have Chromogenic bacteria,or color-producers;Saprogenic,or putrefaction-producers,and Pathogenic,or disease-producers. Again,we may classify them as being an-aerobic or aerobic,according to whether they die or live in the atmosphere. There is a difference of opinion as to whether these minute organisms are animal or vegetable in their nature. Many possess the power of motion,while they take up $CO_2$ as do plants:at all events they are very near the border-line between the two kingdoms. We shall only consider at present those that are presumably pathogenic,and that have to do with the 'germ-theory! The Germ Theory is that the contagious,infectious or specific diseases are transmitted from one person to another,or in some cases,from animals to men or vicé versá,by means of these micro-organisms,the infection being by the air,the drinking water or the food as carriers,or by direct contact. The term contagious used to be applied be applied solely to those diseases which were transmitted by direct contact,and the term infectious to those in which the transmission was by the air,water or food. But we now know that the germs of the former class may also be carried by the air or water,and those of the latter class transmitted by direct contact: So the terms are now used interchangably. The term'zymotic'used to be applied to those diseases occurring in epidemics and which were supposed to be due to fermentative processes:it should now be applied to all those that are presumably due to a living germ. The term 'specific' should only be applied to those which have a specific origin,which have been proven to be due solely to a single living germ. That most communicable diseases are due to such germs is more than probable,but there are some in which it has not been fully proven,and there remains the bare possibility that some of these may arise from insanitary causes without the presence of any definite living germ. Our reasons for believing in the germ theory as an explanation of the causation of infectious diseases are based on empirical and logical as well as theoretical facts. Leaving out,at present,the history of the work already done,it is evident,in the first place,that the matter that causes a disease,the contagium, must,when introduced into a susceptible person or animal,increase in quantity to an enormous extent. Note for instance,the amount of virulent matter thrown off from a case of small-pox or scarlet-fever,and yet how little it took to start the disease. No dead chemical substance has the power of being increased to such an extent by simply finding a lodgment in a suitable medium. The poison of contagion,whatever it may be,evidently must have life and the power of reproduction. Moreover,these causes of disease when freed from the body may be carried long distances through the air or by water,or may exist for years and still retain their power for harm,only waiting to find a suitable field before beginning to multiply and cause the same identical malady as before. No dead matter,solid,liquid or gaseous,exposed to the oxidizing or decomposing action of the air for all that time or through all that space could thus retain its power for evil. But we do know that the spores of many bacteria,or the bacteria themselves,may be carried long distances,kept long periods of time,and even exposed to great extremes of temperature,without being killed or losing their powers of reproduction and rapid multiplication. Again,we know that substances that are poisonous to or prevent the development of other low forms of life do,when properly applied or used prevent or remove the danger of contagion.

There is also a direct analogy to the phenomena of fermentation in the development and progress of any of the infectious diseases;the same rapid multiplication of cells in suitable media at proper temperatures, a period of incubation,then changes in the culture-media which,after going on to a certain extent,check the further growth of the organism in that media. What it is in the medium that checks the growth of the germ we cannot determine a priori,but we can take it to be something hostile to the contagium,as alcohol above a certain percentage is hostile to the yeast-cell,or else we can consider the supply of food requisite for the germ,if it be such,to be exhausted and reproduction checked for want of nutriment. As to what is already proven about the germ-theory;if the proof of Koch's postulates is essential to the acceptance of a given micro-organism as the cause of a given disease,on the other hand,if these postulates be proven about any germ in connection with a disease,we must believe that that germ is a cause of that disease,if not the only one.

These postulates or conditions of Koch are: 1. The micro-organism must be found in the blood,lymph or diseased tissues of man,or animal, suffering from or dead of the disease. 2. The micro-organisms must be isolated from the blood,lymph or diseased tissues,and cultivated in suitable media outside the animal body.These pure cultivations must be carried on through successive generations of the organism. 3. A pure cultivation thus obtained after several generations must when introduced into a healthy animal produce the disease in question. 4. In the inoculated animal the same micro-organism must again be found. In the case of diseases peculiar to human beings alone the third condition must remain undetermined,because we cannot endanger human health or life by our inoculations. But in diseases common alike to men and animals the experiments necessary can be completely carried out,and where a germ can be proven to be the cause,according to these postulates,of the malady in animals,we can fairly conclude that it is also the cause of the disease in human beings. The specific germs of a number of maladies common to man and beast have thus been determined,together with those of a large number of affections peculiar to animals alone.

Disease germs are carried by the air,water or food,or are transmitted from person to person by direct contact. The following table classifies the communicable diseases according to their more general mode of propagation: A. Contagion usually air-borne. Small-pox;Scarlet Fever;Measles; Rötheln;Mumps;Chicken-pox;Whooping-cough;Influenza;Typhus;Relapsing Fever;Diphtheria;Erysipelas;Epidemic Pneumonia.

B. Contagion is air- or water-borne. Yellow Fever;Cholera;Enteric or Typhoid Fever;Dysentery and Diarrhoea.

C. Contagion usually by inoculation. Anthrax;Foot and Mouth Disease;Leprosy;Glanders;Hydrophobia;Vaccinia;Ophthalmia;Syphilis;Gonorrhea;Tetanus

D. Surface lesion necessary for contagion air-borne or directly inoculable. Erysipelas;Pyaemia;Septicaemia;Hospital Gangrene;Puerperal-Fever.

E. Contagion air-borne or by inoculation. Tubercle;(Scrofula;Lupus.)

In Class A the contagion is scattered through the air and many may be attacked about the same time and an epidemic ensue. The diseases of Class B are usually endemic,the germs being transmitted by the drinking water,but may become epidemic when certain conditions increase the virulence or quantity of the poison. With the exception of Erysipelas,Diphtheria,Epidemic Pneumonia and Dysentery,one attack of any of the maladies of A or B seems to protect the system for a time,at least,against subsequent attacks. In Class D we do not know that one attack confers immunity against subsequent ones. As to the question of what constitutes bodily susceptibility,we may assume that upon the reception of any contagion there is a contest between the disease-germs and the cells of the body,in which the strongest wins the battle.

If the cells lack in vital force,as in children,the debilitated and aged,or if the bacteria invade the system in great numbers,we may expect the disease to be incurred;but if the germs are few and weak and the body cells strong and vigorous,the person will doubtless escape the disease. Nor do we have to imagine that the bacteria eat up or detroy the cells, for it has been proven that many bacteria produce in suitable media definite chemical substances,some poisonous,others not. When these are basic in character and resemble the vegetable alkaloids they are called Ptomaines;when not alkaloidal,but having a composition similar to partially digested proteids,they are termed Albumoses. Now,the human system has the power of accomodating itself to almost any of the vegetable poisons, provided they be administered in sufficiently small doses,and can in time withstand quantities that would kill an unprotected person.And,as the system is only the summation of the body cells,it must be them individually that resist the toxic action. So by analogy,since the ptomaines and albumoses resemble the vegetable poisons,it is reasonable to suppose that the cells can accustom themselves to them and resist their action, if only they be produced or administered in very small doses at a time. Many experiments have shown that this can and does take place. But in becoming tolerant to these poisons it is not necessary that the cells lose their power of destroying the bacteria or of holding them in check till they produce sufficient poison to destroy their own reproductive powers. This explains how the body may resist a contagious disease or be entirely insusceptible to it;and also how it may be rendered powerless for harm by a careful and gradual series of injections of the poison produced by the special germ. So also,preventive inoculations may be made of attenuated germs,weakened by heat,by cultivation in medicated or unsuitable media,etc.,such germs being too weak to conquer the body cells unthe latter have had time to accustom themselves to the disease poison.

## LECTURE XIX.

DISINFECTION. That part of prophylaxis which has to do with the destruction or modification of the exciting causes of disease. A disinfectant is"an agent capable of destroying the infective power of infectious material"and disinfection,strictly speaking,has only to do with the use of such agents in proper quantities. But,in a popular sense,the term is used more widely,including in its meaning the use of antiseptics and deoderants. Deoderization is not disinfection,for infective germs may exist without perceptible odor,and many deoderants are entirely incapable of destroying this infective matter. However,an important function of disinfection,as commonly understood,is the removal or destruction of filth and all matters favorable to the growth of micro-organisms,and this is not comprehended in the strict definition. An antiseptic is "an agent to arrest putrefactive changes"or"an agent which retards,prevents or arrests putrefaction,decay or fermentation." It does not necessarily kill the micro-organisms on which the processes depend:and though some antiseptics may do so,all do not,and they cannot be considered or used as disinfectants,as a class. But though pathogenic and saprogenic bacteria are not identical,experience shows that whatever act as true disinfectants in destroying the vitality and infective power of the former will do likewise to the latter,and is,therefore,an antiseptic.Again,to deoderize is not to disinfect:many deoderants are not disinfectants,and some of the best disinfectants,as $HgCl_2$,have no deoderizing powers.Masses of putrefying matter may not,in some cases,contain disease germs and may be even hostile to them;but in general,the reverse of this is true and decaying matter often furnishes a good field for the increase of pathogenic organisms. The noxious gases given off to the air and the poisonous alkaloids to the drinking water from such masses may also do much harm

by depressing the system,lowering the vitality and acting as predisposing conditions to the incurrence of such"filth diseases"as cholera,yellow fever,typhoid fever,diphtheria,etc. So the removal of such accumulations,while not strictly disinfection is part of the duty of a Disinfector. Where neither time nor opportunity are given for the removal of such nuisances,theprocesses of putrefaction or fermentation may be checked,temporarily or permanently,by the application of certain antiseptics.In this way sulphate of iron is of value,it being a good antiseptic but not a disinfectant,for it can be used in large quantities,on account of its cheapness,in drains,cess-pools,etc. The knowledge as to the efficacy of any substance as a disinfectant is obtained from the accumulated experience of practical sanitarians,and from experiments on susceptible animals and in culture media with infectious matter treated with presumable disinfecting agents. The knowledge gained must stand the test of scientific deduction,and a substance is not a disinfectant simply because in one given case infection did not occur after its use. To be of value the deductions must be made from considerable accumulated and practical experience. "Negative evidence should be received with great caution,"but if the experience of practical sanitarians is confirmed by careful culture and inoculation experiments,our knowledge of the value of any agent becomes more definite and our practical work more exact. From these inoculation and culture experiments it has been found that the infectious germs of different diseases differ in their power to resist the different disinfectants;but,nevertheless,it may be stated that"in the absence of spores,a disinfectant for one is a disinfectant for all." Consequently,we are able to simplify and classify the agents at our disposal,and to make more effectual use of them. Note that there is nothing in the tests mentioned to disprove the efficacy of disinfectants,whatever the nature of the infecting material and whether the germ theory be accepted or not. Accepting the germ thepry as proven,however,all bacteria reproduce themselves by division,one individual splitting into two,and so on. The micrococci multiply only by this method,but some of the bacilli also reproduce themselves by"spores," which spores have the power of resisting heat or other disinfectants to a much greater degree than the parent bacilli or the non-spore-producing organisms. Some agents that are powerful against all other organisms completely fail in destroying the vitality of spores,and thus our list of disinfectants available in <u>all</u> cases is still further reduced. In the case of a disease germ that does not produce spores,as that of cholera,and probably also of scarlet fever, small-pox,yellow fever,etc.,agents may be used that are really powerless against spores;but in doubtful cases only those should be used that have the power of spore-destruction. "Agents which kill bacteria in a certain amount,prevent their multiplication in culture fluids,when present in quantities considerably less than are required to destroy vitality." So, since both pathogenic and saprogenic bacteria are destroyed by these agents,a diluted germicide may act as an antiseptic and prevent putrefaction. The reliable and practical disinfectants at our command are:
1. Those that destroy spores. a. Fire, b. Steam under pressure,(25 lbs.) c. Boiling Water, d.Chlorinated Lime(in solution), e. Liquor Sodae Chlorinatae, f. Mercuric Chloride. 2. Those effective in the absence of spores. a. Dry Heat,(250°for 2 hrs.),b. Sulphur Dioxide($SO_2$),c. Carbolic Acid, d, Copper Sulphate(in solution),e. Zinc Chloride(in solution.)

The National Public Health Association recommends that these agents be used as follows: For Excreta; a. In the sick-room:-Chlorinated Lime, 4% solution. In the absence of spores:-Carbolic Acid,5% solution,or Copper Sulphate,5% solution. b. In cess-pools:-$HgCl_2$,1/500,or Carbolic Acid 5% solution. c. For the disinfection and deodorization of masses of organic matter in privy-vaults,etc.:-Chlorinated Lime in powder.
For clothing,bedding,etc.:-a. Soiled underclothing,bed linen,etc.:-Destruction by Fire,if of little value.Boiling for at least half an hour,

Immersion in $HgCl_2$,1/2000,or in Carbolic Acid solution,2%,for four hrs. b. Outer garments of wool or silk,and similar articles which would be injured by immersion in hot water or disinfecting solutions:-Exposure in suitable apparatus to a current of steam for 10 minutes,or to dry heat at 230°F.for 2 hrs. c. Mattresses and blankets soiled by discharges from the sick:-Destruction by fire,exposure to super-heated steam for 10 minutes,(mattresses to have covers removed,)or immersion in boiling water for half an hour. For Furniture and articles of Wood,Leather and Porcelain:-Washing,several times repeated,with 2% Carbolic Acid solution. For the Person. The hands and general surface of the body of attendants,of the sick and of convalescents should be washed with a 10% solution Chlorinated Soda,diluted 1 to 10,or 2% Carbolic Acid solution,or $HgCl_2$,1/1000. For the Dead:-Envelope the body in a sheet thoroughly saturated with 4% Chlorinated Lime solution,or 5% Carbolic Acid solution,or $HgCl_2$,1/500. For the sick-room and hospital wards. While occupied wash all surfaces with $HgCl_2$,1/1000,or Carbolic Acid,2%. When vacated,fumigate with $SO_2$for at least 12 hrs.,burning 3 lbs.S for every 1000 cu.ft. air-space in room: then wash all surfaces with one of the above solutions,and afterwards with soap and hot water:finally ventilate thoroughly."Generally,in the absence of spores,(and no human disease has any as far as we know,)heat of 250°F,$SO_2$ in fumes,and solutions of $HgCl_2$ will destroy all pathogenic germs."

Of the above agents,Fire is the most efficacious,as it destroys all organic matter;but it can only be used to disinfect articles of little value. As a rule,it will cost more than they are worth to thoroughly disinfect by other means old clothing or bedding that has been soiled or used in an infectious case;so that they had best be burned. Steam from boiling water in an open vessel has only a temperature of 212°,but under 25 lbs.pressure it has a temperature of 240°,and is effective against the most resistant spores almost immediately. Moist heat at 230°kills spores in 20 minutes. In the absence of spores,bacteria are killed by hot water below the boiling point,and it is safe to say that boiling for half an hour will destroy all known disease germs,including anthrax spores,tho' spores of certain harmless bacilli resist boiling for several hours. Chlorinated Lime,(Chloride of Lime popularly,)is one of the best and cheapest disinfectants. It should contain at least 25% of available Cl, should be kept covered from air and moisture,and fresh solutions should always be made as needed. Its power is due to hypochlorite of lime,which is freely soluble in water,readily decomposes in contact with organic matter,giving up Cl,a most powerful disinfectant."Germs of all kinds,including the most resistant spores,are destroyed by this solution;but it must be remembered that the disinfectant itself is quickly decomposed and destroyed by contact with organic matter,and that if this is present in excess,disinfection may not be accomplished,especially when the germs are embedded in masses of material which are left after the hypochlorite of lime has all been exhausted in the solution." Labarraque's solution,a solution of Chlorinated Soda,is a fair disinfectant,but does not keep well,and Chlorinated Lime is equally as good and much cheaper. However, the soda solution has scarcely any disagreeable odor,and makes a pleasant disinfecting bath for the person. It must contain at least 3% available Cl. Bichloride of Hg is one one of the best germicides that we have and is effective in comparatively weak solutions. It corrodes metal and so cannot be used to disinfect waste-pipes,etc.;and it combines with and coagulates albumen,which interferes some what with its action. This coagulation is,I believe,prevented to a degree by the addition of tartaric acid to the disinfecting liquid.

It must be remembered that with all disinfectants time is a necessary element in securing the desired effect, and that it does not disinfect an article to subject it to the $HgCl_2$ solution for only a few seconds. Dry Heat, to be effective, must be of such a high temperature that it will injure many fabrics. Moreover, its penetrating powers are very slight, and considerable time must be allowed for its action. It is only to be used where moist heat or solutions would injure the articles to be disinfected. Spores require a temperature of 284° of dry heat for 3 hrs. to destroy them; bacilli without spores, 230° for 2 hrs. Sulphur Dioxide($SO_2$) is one of the best gaseous disinfectants, and is especially useful in fumigating rooms, and articles that cannot be subjected to steam-heat or solutions. It probably kills all germs not containing spores, and acts best in the presence of moisture, and in rooms as nearly air-tight as possible. Carbolic Acid is effective in the absence of spores, and according to Koch, should have the first place in disinfection against the cholera-germ. For excreta, it is to be used in a 5% solution; for clothing, etc., in a 2% solution. Copper Sulphate is a good disinfectant in the absence of spores, is a deodorant and is cheap. It may be combined with $HgCl_2$ to color the solution and to get the benefit of its deodorant powers, which $HgCl_2$ does not have. Zinc Chloride is a good antiseptic and deodorant, but not a very powerful disinfectant. A 5% or 10% solution will kill germs without spores.

## LECTURE XX.

DIETETICS. Will consider the substances which are necessary or useful as food for the human body, and how these may be prepared in the most healthful, rational and economical manner. The physician should have not a little knowledge of food and its preparation. "The day of Dietetics has arrived. The time indeed is at hand whem systematic lectures on Food is to be a part of Medical education; while the value of feeding in disease is admitted to be as important as the administration of medicines." Study Fothergill's Manual of Dietetics; also Healthy Homes and Food for the Working Classes, by Vaughan, and Practical, Sanitary and Economic Cooking, by Mrs. Abel, the latter two being essays published by the A.P.H.Assn.

Dietetics means "a systematic regulation of the diet for hygienic or therapeutic purposes." It is not alone necessary to determine just what substances, in a chemical sense, the body needs to sustain life and maintain health: experience soon shows that we must also take account of the aesthetic factors of digestion and be mindful to please the taste, and often the smell and sight, to get the most benefit from our food. Nor is it sufficient to say that a man must have just so much of this and so much of that food: there must be a constant variety not only in quality or kind, but also in quantity to meet the varying demands of the system. No matter how toothsome or healthful a dish may be, it soon palls upon the appetite if necessity compels its continued use for any length of time, and the disgust may be so impressed upon the memory of the senses as to prevent the use of that food forever after. Moreover, the question of pleasing the appetite has much to do with the perfection and completeness of digestion, and, other things being equal, palatable and acceptable foods are disposed of even in sickness much more satisfactorily than others not so. In sickness the appearance and palatability of food has much to do with its acceptance, not only by the patient, but by his stomach. It pays in all cases where diet has a place, and that is every one, to see that the food is served in the neatest and most attractive mannerwith with the best china and cleanest napery that the house affords. A little tact in this way will often enable the patient to take and retain the nourishment he needs, even when he asserts and believes this to be impossible. The use of food is for a three-fold purpose; -to repair waste, to furnish force for the action not only of the muscles, but of all the organs and tissues of the body, and to build up the body-structure.

Classifying foods according to the different digestive processes;i.e. according to the chemical composition of the food itself,all necessary foods are under one of the following heads:-1. Proteids or Albumenoids, 2. Carbo-hydrates, 3. Fats, 4. Salts and Extractives,and 5. Water,if we take that to be a food. Experience and experiments both show that all five of these are absolutely necessary to sustain life for any considerable length of time,and that with them nothing else is necessary;though the volatile odors and flavors are desirable and advisable as adjuncts to the food proper,favoring its reception and digestion. Each food has its special function in the economy of digestion,though in times of need any one of the first three may,in a way,supply the place of either of the other two. "The carbo-hydrates are the body-fuel,the surplusage being stored as fat;the albumenoids serve to repair the tissues as they wear out:the salts form the blood-salts;the fat helps to build up normal health-tissues,the excess being burnt as body-fuel.That is the real object of food."The water also goes to preserve roundness of form,to keep the body-juices in a proper state of fluidity and,above all,to wash out waste matters from the system. According to Vaughan,the average working man requires daily,in round numbers, not less than four ounces of proteids,two ounces of fat, and eighteen ounces of carbo-hydrates. In addition to these he also needs a small amount of salts and from 70 to 100 ounces of water,a good part of this latter being taken in,however,in combination with the food. Any combination of foods giving the above amounts at a low cost will be an economical diet,provided such food is acceptable to the palate,is digestible,and contains nothing harmful to the system. Such combinations will be found in the essays of Vaughan and Abel,to which I called your attention. Fothergill thinks that we,as a rule,take too much albumenoid food,especially meat;and that though this goes for tissue repair,this last is much less than we ordinarily suppose and we do not need much albumen. To sustain himself in this view he has said"Albumen is a complex body containing nitrogen.Nitrogen is the cardinal matter which fits the albumen for the non-oxidizable framework of the body in which the combustible hydro-carbons are burnt",and then quotes Liebig,who says"Of all the elements of the body,nitrogen has the feeblest attraction for oxygen;and what is still more remarkable,it deprives all combustible elements with which it combines,to a greater or less extent,of the power of combining with oxygen;that is,of undergoing combustion." So,"by virtue of the nitrogen factor,the albuminous are prevented from the body combustion extending to them." Probably he is right to a certain degree,particularly regarding his fellow-Englishmen,who are notorious meat-eaters;that tissue-waste is comparatively slight,and that the body framework rusts out rather than burns out,the force for action coming from the carbo-hydrates,and occasionally from fat. But we must not forget that animal food is concentrated food,that it is stimulating, that much energy has been expended in its production from vegetable food and our digestive apparatus saved that much work,and that our digestive organs,their weight being compared with that of the body,resmble more closely those of the carnivora than the herbivora. All these,coupled to the fact that proteids make up a considerable part of the only typically complete food that we have and which Nature gives to the mammalian infant at birth;viz.,milk,make me feel that we should take care to use neither too little nor too much of meat food. The line on both sides must be stretched with care,but must be flexible. The proteid portion of our food is customarily obtained from meat and fish,from milk and eggs,and from the gluten of cereals and the vegetable albumen of the leguminous plants,as peas,beans,lentils,etc. The proportion of albumen varies,of course,in each of these,and even in the same kind under different circumstances;but all should be taken into consideration and used if we wish to obtain the greatest variety and benefit in feeding,together with due economy. THe albumen differs also in property in the different foods.

The albumen of meat juice is coagulated by heat,that of casein is softened,as in the cooking of cheese,etc. Gastric digestion means practically the hydration of albumen and albumenoid substances,thereby forming peptones. Whether or not coagulation renders albumen more digestible,cooking,in the case of meats,facilitates the action of the gastric juice by separating and making more brittle the muscular fibrillae;and,in the case of vegetables,by softening and prehydrating the gluten or vegetable albumen or casein.

The Carbo-hydrates that furnish fuel to the body,the source of the heat and energy on which muscular action and vital activity are dependent,are derived practically,with the exception of milk-sugar,from the vegetable kingdom:the chief of these are starch,sugar,gum and dextrine. Starch is insoluble;if it were not,it would be washed out of the growing and ripening grain by the rain and could not be collected. Sugar is a hydrate of starch,and the latter is converted into the former,in the presence of moisture,by diastase,an albuminous ferment. This diastase is found in the seeds of germinating plants,in human saliva and in the pancreatic juice.It is in the seed to convert the starch into soluble sugar and thus furnish food for the baby plant.Midway between the starch and sugar maltose is formed,soluble and having the same formula as cane-sugar. In the mouth and intestinal tract the diastase converts the starch into soluble grape-sugar,that it may be absorbed by the vessels of the alimentary tract. In the salivary digestion this conversion is only partial and,in a sense,incomplete,soluble dextrine being formed.But this salivary digestion,though only partial,allows the stomach to act more freely upon the proteid portions of the food,by the removal or conversion of so much starch as it acts upon;and besides,the accompanying mastication favors the pancreatic digestion also,in that it breaks up the starch granules and exposes them the more freely to the action of the pancreatic juice. This last object is obtained in a more advantageous manner by grinding the starch granules in a mill or by cooking them. Heat also,in the presence of moisture,converts the starch largely into soluble dextrine,leaving the saliva only to further change this dextrine into grape-sugar and the remaining starch into dextrine."Grinding and cooking lessen the labor of the jaw and salivary glands." To make plain the difference between cane-sugar and grape-sugar in the alimentary canal,Pavy says:"Although cane-sugar requires no digestion to fit it for absorption,it may be considered probable that it undergoes conversion into grape-sugar,certainly in part,if not wholly before leaving the alimentary canal.If cane-sugar be introduced into one of the vessels of the general circulation,itpasses off from the system without being utilized and escapes,still in the form of cane-sugar,in the urine.If,however,cane sugar be introduced into the alimentary canal beyond the capacity,say, for subsequent assimilation,sugar similarly passes off with the urine, but now in the form of grape-sugar instead of cane-sugar." Now,just as the soluble peptones taken up by the portal vessels are reconverted into insoluble proteids to form the serum-albumen of the blood and the body-framework,and to prevent their immediate excretion;so also the soluble grape-sugar,absorbed by the same vessels,is reconverted in the liver into animal starch or glycogen,and this becomes the body store of fuel. Fothergill says "The liver stores up from each meal so much glycogen,and gives it off as required;otherwise life would be only one dreary meal." But though an excess of proteids is oxidized and finally excreted from the body as urea,here any excess of sugar is further stored away as fat or adipose tissue on different parts of the body,a further reserve of body-fuel for any emergency. That is,provided the liver is healthy and able to handle the excess of sugar;if it is not,the excess passes off as sugar through the kidneys,and if the imperfect action of the liver is permanent we have the disease,-Diabetes.

Fat is essentially a combination of glycerine with one or more of the three fatty acids,stearine,palmatine and oleine. Of these,stearine has the highest melting point,and oleine the lowest. And as the digestibility of a fat depends upon its fluidity at the body temperature,the more stearine a fat contains,the less digestible it is.For this reason butter is more digestible than suet,lard than mutton-fat. Fat is derived from vegetable as well as animal sources:many seeds and nuts and some grains, as oats,contain much fat. Fat stored up in the animal body is held there as a reserve supply of body-fuel;but fat taken as food or along with it is not itself stored up or deposited as fat in the body. Its primary object is to repair or build up tissue,if this is needed,the excess being oxidized as fuel to give heat and force. Ebstein's Cure for obesity is based on this principle,and substitutes fat in considerable amount in the food for the carbo-hydrates. Also,one of the best means we have of keeping up the body-weight and preventing wasting of tissue in Phthisis is by the free administration of digestible fats,as cod-liver oil,etc. Note that the most easily digested cod-liver oil is that from which the stearine has been removed. As fat contains much C and H and but little O it is a concentrated fuel-food and is to be used freely when we want to keep the body warm in cold climates or weather,or when we are to call upon the muscles for work and need force for any increased exertion.

The digestion of fat is a process of emulsification rather than hydration,as is that of proteids and carbo-hydrates,the object being to make the fat globules small enough to be taken up by the lacteals of the intestinal tract. In the body the emulsification is effected by the combined action of the pancreatic juice and bile,and not by the gastric juice. Fat is practically a foreign body in the stomach,and some stomachs cannot tolerate it,especially if given with other food.Consequently,to administer it most acceptably to those cases in which you feel that large quantities should be supplied,give it an hour and a half or two hours after meals,when the gastric digestion is about completed and the food is passing out of the stomach to be further subjected to the intestinal digestion.In this way you will generally have but little trouble,even in administering cod-liver oil with its disagreeable taste and odor. You will know when you are giving too much fat by finding it passed unchangin the faeces;all that escapes in this way is,of course,wasted. It may be well to partially or wholly emulsify the fat before administering it, thus saving the bile that much work,especially when there is scanty excretion of the latter. Sometimes also the body can be made to take up considerable fat by inunctions,and that much less need be taken by the mouth. Again,cod-liver oil is very digestible,but we may often escape it's use by giving milk,itself an emulsion of fat,either in its natural state or still further broken up by beating or by adding alkalies,an hour or two after meals. Or cream,emulsionized and flavored,may even do still better. The trouble with many prepared fat emulsions is that after a time the globules coalesce and the emulsion is destroyed. Mark what Fothergill says."Whenever there is any tendency to tubercle,the individual should learn to eat fat,just as a sea-faring man learns to swim.As a physician to a Chest Hospital I have learned to dread the announcement that fat is no longer taken,especially if the individual is of strumous build,with a small narrow chest.In my opinion,the existence of a considerable area of affected lung where the digestive powers keep up,is less fraught with evil and less prognostically significant than intractable wasting with very little disease in the lung." He also points out that fat does not cause 'biliousness' by acting as an irritant to the liver, but that the taking of fat may so improve the digestion that the "liver is upset by the new demand upon it;but this can always be met by a cholagogue and purgative.

Certain salts in certain proportions are necessary for the maintenance of health in the body. According to Foster, "We know that various saline bodies are essential to health, that when they are not present in proper proportions, nutrition is affected, as is shown by certain forms of scurvy; we are aware of the peculiar dependence of proteid qualities in the presence of salts; but beyond this we know very little." Not only the common NaCl, the phosphates and other Na and K salts must be givenin proper supply, but also some of the organic vegetable salts, to prevent conditions akin to scurvy. If for no other reason, we could fairly consider salts necessary, because we find them ever present in milk, our one complete food. Pavy says, "Caseine is conspicuous for the tenacity with which it holds a large quantity of phosphate of lime incorporated with it." We need the phosphates for our bones, nerve-food and red blood corpuscles. NaCl furnishes Cl to form the HCl of the gastric juice; and the Na and K act as bases for the many complex organic salts of the body, both of secretion and excretion.

Remember that we need an abundance of water not only to keep the tissues bathed in moisture and to keep the body-juices up to their proper degree of fluidity, but to flush out waste matter from all parts of the organism, and to carry off those excrementitious substances whose retention gives rise to the symptoms of autogenetic maladies. The sewers of the body need flushing and cleaning even more than do those of a city. It is worth remembering also that the free use of fluids is thought to favor an increase in the quantity of fat deposited.

With many of our foods, as condiments and sauces, which have little or no food value themselves, yet do much good, when not abused, by stimulating the secretion of the digestive juices, or by making the food itself more acceptable to the taste, or by acting as carminatives, especially with a vegetable diet. I use the term sauce here as being a combination of condiments, more or less complex. Fothergill cautions that these condiments be not omitted from the dietary of the sick, for they have a value of their own, and he says "Condiments are agreeable to the palate, and, in moderation, good for the digestive organs.

MILK is our typical food-stuff, complete in itself and in itself able to sustain life indefinitely. It contains the food principles in proper proportion, the casein and albumen representing the proteids; the milk-sugar the concentrated carbo-hydrates; the butter the fat; the salts and ash the salts, all well diluted with sufficient water. The albumen of milk is coagulated by heat; the casein by the addition of an acid or rennet, or by fermentative changes in the milk converting the milk-sugar into lactic acid and 'souring' the milk. When milk is taken into the stomach it is curdled and a clot is formed: that this clot may not be one large, firm, indigestible mass, but finely subdivided and everywhere subject to the action of the gastric juice, milk should always be taken slowly, never hurriedly, or else mixed with other food that will mechanically divide the curd. Or an alkali may be mixed with it to diminish acidity and soften the curd. Milk is of prime importance in sickness, but care must be had regarding the above points, for too large or too solid clots may cause gastric and intestinal irritation, or even greater damage. It may be too heavy for some stomachs, especially for infants, and will have to be diluted accordingly; and for young consumers for whom it forms the bulk of their food, it may be wise to add to the diluted milk some additional carbo-hydrates in the form of milk-sugar, maltose or malt extract. For this same class of users, and in all cases where the milk may by any possibility have been exposed to the germs of specific diseases or of fermentation, it should be sterilized by heating to at least 212°F. for at least 20 or 30 minutes. It should always be kept as cool as possible and covered, not only to exclude dirt and bacteria, but to prevent absorption of disagreeable or harmful odors or gases, to which it is very prone.

Sterilized milk, protected from the accession of germs, will not 'sour', no matter how long it be kept. Boiling slightly alters ~~the properties of~~ milk by coagulating its albumen, but it is doubtful whether it makes much difference in its digestibility. The cream of milk is fat in a most digestible and acceptable form, and should not be removed from the milk if the latter is to be used as food. But if the milk seems indigestible on account of the cream, it may be advisable to skim it and give the skimmed milk with the regular meal, following it a couple of hours later with the cream, as was suggested. However, skimmed milk and butter-milk may be used freely as beverages, as both are refreshing and healthful with some food value, and butter-milk is especially acceptable to many persons on account of the lactic acid it contains. Milk may also be predigested for the ill by the addition of rennet with the best results, and for all persons it can be made a constituent of many agreeable and healthful dishes. Even after the casein and fat have been removed in the form of butter or of cheese, the whey has some food-value on account of the salts and milk-sugar it contains. Cheese is amost valuable food-stuff, containing twice as much N and three times the fat of the same weight of meat, but with many persons it is difficult of digestion and large quantities of it cannot be eaten. This is perhaps because it contains the nutriment in such a concentrated form, and in such a physical condition that it forms a solid mass in the stomach into which the gastric juice cannot penetrate. Mattieu Williams has remarked that we habitually use it in the states in which it is most indigestible, raw or fried into a leathery mass; and he asserts that if it be cooked in such a way that it is thoroughly mingled with other particles of food, or well masticated with other food so that this commingling of particles takes place, it will be found quite digestible. He also advises the use of a pinch of potassium carbonate in the cooking, as this favors the solution of the casein and is one of the valuable salts removed in the whey.

Eggs furnish considerable food in a concentrated form, and are valuable on this account, as well as for their flavor and the adaptibility with which they lend themselves to the preparation of many dishes. They contain practically no carbo-hydrates, and yet have sufficient food material that the living chick is developed in the egg without the aid of anything external except the O that passes through the shell. The reason why the carbo-hydrates, one of the essential principles of food, is because the chick being confined wastes no heat on energy in motion, and that all heat necessary for vital processes is supplied by the mother-hen or incubator. The white of egg is almost pure albumen with a little water and some salts; the yolk contains about 30% of fat and some albumen. The albumen coagulates at about 170°F. and if the egg is exposed to higher temperature for any length of time, it becomes hard and difficult of digestion, while a 'soft-boiled' egg is not much more difficult to digest than a raw one. To cook an egg in the shell properly it is only necessary to drop it into sufficient boiling water to cover it, say a pint to the egg, at the same time removing the water from the source of heat. The egg cooked in this way in a few moments is jelly-like and very digestible; and cannot be over-cooked for the water coolsttoo rapidly below the coagulating point. Eggs and milk may be made into many nutritious combinations, and furnish food especially agreeable to the sick.

LECTURE XXII.

Meat is a concentrated food; it is used on account of the large amount of nutriment and for its richness in flavor. It represents much vegetable matter converted into its present form by the digestive energy of the animals which yielded it. It contains all the essential elements of food, the carbo-hydrates, however, being present in but a small proportion, and being represented by muscle sugar or inosite. In all meat there is much water, but more in lean meatthan in fat. Fat bacon contains 60%, lean beef, 75% water. As the amount of fat increases the quantity of albumen-

oids decreases;thus lean beef has only 1 or 2% of fat to 22 or 24% of albumenoids,while fat bacon has 24% of fat to 15% of albumenoids. The flesh of young animals is more tender but not as digestible as that of adults,partly because the young flesh cannot be thoroughly masticated. "Young flesh is less stimulating and nutritious and more gelatinous than that of the adult."(Vaughan.) Meat cooked before rigor mortis sets in is tender;cooked during the rigor,meat is tough and hard to masticate;after the rigor has passed meat becomes tender again,if it was so originally. In cooking meat every part should be heated to at least 160° to destroy any disease germs or parasites it may contain:very rare meat may still contain these organisms alive. Tuberculosis may be incurred by eating tuberculous meat,if it be not well cooked. The development of ptomaines in decomposing meat may make it very poisonous. Gerlach,of Berlin,gives the following as meats that should not be eaten:-1.The flesh of all animals dead of internal diseases,or which have been killed while suffering from such diseases,or animals killed by over-driving. 2.The flesh of animals with contagious diseases that may be transmitted to man..3.The flesh of animals which have been poisoned. 4.The flesh of animals with severe in fectious diseases,as pyaemia,etc. 5.Flesh that contains parasites that may be transmitted to man. 6.All putrid flesh.

We cook meat to improve it in appearance and to make it more agreeable to palate and digestion. We should always keep in view the ultimate condition in which we wish the meat;and should take pains not to overe cook it nor to use too high a temperature. The processes of making a good soup and of boiling a piece of meat so that it may retain all its juices,salts and flavor,are radically different,though the same quantity of added ingredients be used in both cases. In the first,it is desired to extract as much of the soluble constituents as possible,and to obtain this the meat should be cut into small pieces and placed in cold water, which is very gradually raised to the neighborhood of 160°.This allows the juices to exude,and the salts and soluble parts of the meat to be dissolved by the water before the pores are closed by the coagulation of the albumen. But soups made of meat juices alone without the addition of other substances are stimulating rather than nutritious,as they contain little or no albumen,carbo-hydrates or fat.But if certain vegetables be added to the soup,the latter may be very nutritious;and such soups are of great value in all schemes of economic cookery. While soups made from meat alone are not nutritious,the meat left after making soup is not all that could be desired,for it has lost its salts and flavor,and though it still contains fat and albumen,it is unsavory and is not easily digested. It needs something,a sauce or condiment,or preferably a meat extract,for meat extracts are nothing but thin soups evaporated to dryness or condensed. However,if both the soup and the meat from which it was made be taken at the same meal each supplies the need of the other. Bones are valuable in soup-making on account of the gelatine and the soluble organic matter they contain.Long bones should be broken,and all bones should be boiled for several hours to get all the valuable constituents.Used with vegetables they make especially nutritious soups and ones easily digested. If it is desired to retain the juices in the meat,the piece should be as large as possible,so that the surface exposed will be small in proportion to the bulk. The piece is first subjected to a high temperature,so that the surface is at once cooked and the albumen coagulated, the pores being thus sealed so that the juices cannot escape. In boiling this end is attained by plunging the meat in boiling water;in roasting, by having the oven very hot.After this first heating it is best to diminish the degree of heat somewhat so that the cooking of the interior may go on more slowly and that the temperature inside may not rise much above the coagulating point and the meat be made hard and stringy. Broiling is but a modified roasting,and should be done by first bringing the

piece near the fire to seal the exterior,and then finishing the cooking at a farther distance from the coals,thus keeping the interior tender and juicy. Stewing meat is simply cooking it in its own juices,and these latter should always be served with the meat,which should have been cut into small pieces. It improves the flavot of vegetables to add them to a stew. Frying meat,as commonly practiced,should not be tolerated.It renders the albumen of the meat extremely tough,besides soaking it with fat or grease,and greatly increases the difficulty of digestion. But frying by total immersion is an excellent way of cooking meats containing much water,and especially fish,for the boiling point of fat or oil being very high,the meat is cooked on the outside instantly,while the water in the interior,being converted into steam,cooks the albumen,prevents the ingress of fat and leaves the flesh in a light,flaky condition.
Beef tea is only a thin beef extract,of whose stimulant properties we will speak later.That is,beef-tea as ordinarily made. To make a beef-tea containing nutriment,the beef from which the juices have been extracted should be dried,pounded fine,all fibre and tendinous portions removed, and this pounded beef then added to the extract.This is really a food. In making the extract the meat should be cut into small pieces and added to cold water,about a pound of meat to a pint of water,and the whole brought to the boiling point very slowly.Don't forget to season it with salt,at least,for the sick.

Of the different meats,beef is most nutritious. Good beef should not be too pale or too dark,should show no blood-clots,have almost no odor, be elastic to the touch,be well marbled with clean white fat,and have compact flesh. Dark beef indicates that the animal was not properly bled or had some febrile disease;wet and flabby meat,that it is approaching decomposition. Veal should not be too pale as that indicates ante mortem bleeding or too young an animal.The calf should be at least a month old. Veal is not as digestible as beef,nor lamb as mutton.Calves'bones and feet yield considerable gelatine,from which nutritious dishes may be prepared; Mutton is more digestible than beef,but not so nutritious.Veal and lamb may be cooked by immersion in hot oil,as described. Pork is an economical food for the poor man,as good pigs store up three times as much of the food they eat as does the ox.The flesh is easily preserved by drying,and ham and bacon are exceptions to the rule that dried meats are more indigestible than fresh ones.Pork-fat also furnishes much heat in cold weather by its oxidation and combustion in the body. The flesh of poultry is acceptable,if not too old and tough. White meat is more digestible,but not so nutritious or rich in flavor. Chicken broth is nutritious,more so than mutton. Fish is not sufficiently stimulating to constitute the chief flesh diet of a people;but furnishes a variety.Some fish are poisonous,either by nature,or from inhabiting foul waters,or from advancing decomposition. White-meated fish are more delicate and digestible,but not so stimulating as those of red meat. Of cooking Fothergill says"Its effect upon muscle is to loosen the bundles of fibrillae from each other,so that they are readily torn asunder or crushed by the teeth:that perfectly cooked flesh is more savory than either underdone or overdone meat;that if meat be not chewed but bolted,the solvent gastric juice can only act on the exterior of the mass;while'lumps'offend the stomach and arrest the gastric secretion." Foster says that in the stomach "the natural bundles of meat and vegetables fall asunder;the muscular fibres split up into discs,and the protoplasm is dissolved from the vegetable cells."

Vegetables. The cereals form one of our most valuable kinds of food. All but rice contain considerable proteid matter,from 10 to 12%,besides carbohydrates which predominate,some fat and a goodly proportion of phosphates. Rice has only 5% of proteids to 75% of starch,but is easily digested and is a valuable food for the young and sick.It is also well fitted for dwellers in hot climates on account of its low heat production.

Wheat is the most nutritious cereal,and bread from wheat is aptly called 'the staff of life';as it is a food which,with the addition of a little extra albumen and fat,furnishes the essentials for the support of life. Oats furnish a valuable food,on account of the large amount of fat they contain,over 5%,together with a full share of proteids,starch and salts. Corn furnishes a cheap and valuable food,with considerable fat. The proteid constituents of cereals are vegetable albumen,casein and gluten,the last of which is most abundant in wheat. Corn contains vegetable fibrine. Grinding breaks up the grain and starch granules of cereals,aids in separating indigestible parts and renders the starch more suitable for cooking and digestion. Good wheat flour should be smooth and soft,but not too white,as it should contain everything but the outer branny coats of the grain,and while all of the gluten does not reside in the inner coats as was formerly taught,these coats do hold some besides the bulk of the grain-salts. Flour should be kept well covered in a dry place,and should contain no living organisms nor any adulterants. Corn meal should also be dry and powdery,not granular. Bread is practically made of flour,water and salt,though milk,sugar,etc.may be added to improve the taste. As flour and water alone make a tough and indigestible mass,bread is leavened to make it easier for mastication and digestion.We obtain this result by the use of yeast,baking powders or aeration. Yeast at the proper temperature converts starch or sugar into alcohol and $CO_2$,the latter in escaping fills the dough with many holes and makes it light,the bubbles being kept from collapsing by the tenacity of the dough till the heat has fixed them. As the heat dissipates the alcohol and $CO_2$,besides checking the fermentative process,from 10 to 12% of the weight of flour used is lost.Moreover,if the fermentation goes beyond a certain point, lactic and acetic acids are formed and the bread becomes'sour'.For these reasons,it has been advised that the yeast method be discarded and the leavening be done by means of baking powders.From these $CO_2$ is evolved upon the application of heat and moistureand the bread is made light by the gas as when yeast is used. These powders consist of a mixture of sodium bicarbonate with an acid salt like acid potassium tartrate,or simply of ammonium carbonate,together with a small amount of starch to keep them dry and prevent loss of strength. They should contain no alum or other adulterants.Alum unites with the phosphates preventing their digestion and absorption by rendering them insoluble. Bread may be leavened on a large scale by forcing $CO_2$ under pressure into the dough,or by mixing the flour with water saturated with the gas:the water should be very cold,so as to retain as much gas as possible. Good bread should be light white,sweet,filled with cavities,and with a crust easily broken and equal to about a quarter of the loaf. As considerable of the starch has been converted into dextrine in the crust,it is more easily digested than other parts of the loaf. Bread only needs a little more albumen and fat to make it a perfect food.

The vegetables in common use are valuable articles of food,in that they give us the bulk of our carbo-hydrates and furnish an agreeable variety day after day. In their fresh state they contain considerable water from 75 to 90 or 95%,the residue being mainly carbo-hydrates. The leguminous group,embracing peas,beans,etc.,is an exception to this,as the seeds of these plants contain much proteid matter,about 24%,about 49% of starch and but little water. The proteid here is vegetable casein;that of the cereals,principally gluten. Green peas and beans are much more digestible than dry ones,and the latter should always be well soaked and cooked in soft water. All vegetables should be cooked so as to retain the salts,or else the water in which they are cooked and which contains these salts should be used in making soup or broth and this served with them. This is especially necessary with potatoes and sweet potatoes,as their salts have much to do with their digestibility.It is for this reason that a roasted potato is always better than a boiled one.

Williams has even suggested that one reason why gout is so prevalent in England is because they there habitually eat boiled vegetables and throw away the water in which they are cooked. The salts not only help to digest the starches, but furnish bases to unite with and render soluble the irritating acids that produce the gouty symptoms.

Potatoes contain much starch, but little proteids and fat, and so need the latter added to the meal. On account of their cheapness and ease of growth and storage they make a good food-stuff for the poor man. Beets contain much sugar and are nutritious, pleasant and digestible. For the same reason parsnips, carrots, etc., are good food-stuffs. Cabbage, cress, spinach and other greens are especially valuable for the organic salts they contain and as relishes, but should be well cooked. Celery and lettuce act as nerve sedatives. Asparagus acts as a diuretic and is thought to be of especial benefit to the kidneys. Fruits are especially valuable on account of their flavor, acceptability to the palate and benefit to digestion, and for their laxative action. Ripe fruits may be eaten freely, but preferably in the morning. Fresh fruits are better than those canned or dried, but all should be used throughout the year. Nuts are nutritious on account of their fat, but are hard to digest. The prepared starches, as arrow-root, sago, tapioca, etc., are very digestible and useful in the preparation of food for the sick.

| | Proteids: | Carbo-hydrates: | Fats: | Salts. |
|---|---|---|---|---|
| Digestion:- | Hydration. | Hydration. | Emulsification. | Solution. |
| After absorption: | Dehydration. | Dehydration. | Oxidation. | Chemical combination. |
| Purpose:- | Tissue-repair. | (Fuel-food.) | Tissue-formation; then Fuel-food. | Body-salts. |
| Excess:- | Excreted as Urea & Uric A. | Stored as fat. | Unabsorbed; excreted unchanged. | Excreted. |

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## LECTURE XXIII.

STIMULANTS. The stimulants with which we are most concerned in daily practice, excluding drugs, are of three classes, nitrogenized animal stimulants, as beef-tea, nitrogenized vegetable stimulants, as tea and coffee, and alcohol. All these are, as Fothergill calls them, "force liberators," though alcohol may sometimes act the part of a "force producer." But the essential function is to liberate force without giving anything to renew or replace what they have set free. Beef-tea, for example, constantly stimulates the vital and nervous functions to greater action, and for this action either tissue or food must be oxidized to produce the necessary energy. But beef-tea gives no food itself, and unless food be supplied in addition to it the body tissues themselves must be consumed. To give beef-tea alone to the sick, whose tissues we are trying to build up rather than tear down, must consequently be, in the end, disastrous. This is of beef-tea as ordinarily made, not the 'whole beef-tea', the recipe of which has been given. The ordinary beef-tea contains the salts of the meat and the extractives, like kreatin and kreatinine, but no albumen: the salts, (phosphates) do help the nerves and the extractives have their value as stimulants; but these latter are waste products of the body, used up in in the wear and tear of life, and one of the intermediate steps between living and active tissue and the final excretory products, urea and uric acid. They are of use to liberate force in sudden emergencies, to tide the system over important crises, to whip up a flagging digestion so that it may accept food to repair waste and furnish fuel; but care must be had that such food is always supplied along with or during the stimulation produced by the agents in question. In sickness or disorders of assimilation soluble carbo-hydrates are demanded even more than the albumen, as they furnish fuel, and consequent heat and force to carry on vital processes; and you will find that these in some form or other will generally be well received and retained by the patient.

We must not depend on ~~stimulants~~ alone to the exclusion of other food, must not continue their use any longer than is necessary to obtain our object, and must not over-stimulate or carry the action so far that the body is left weaker and poorer in force after stimulation than before. The active principles of our nitrogenized vegetable stimulants resemble very closely not only the meat extractives, (kreatin and kreatinine,) in chemical composition, but also those drugs, like strychnine, that we use in medicine as tonics and cerebro-spinal stimulants. As beverages, tea, coffee and cocoa supply fluid for the system and that stimulation of the assimilation that gives the sense of comfort after their use. But these can be abused just as much as beef-tea or alcohol, and 'tea-drunkards' are not uncommon in our hospitals. The tea-cup is not always one that 'cheers but does not inebriate'. Note that among all nervous, energetic people the use of some of these stimulant beverages is common, and that with us 'total abstainers' seem instinctively to take to tea or coffee. Women especially who drink much tea are apt to be nervous and dyspeptic, to have the 'tea-drinker's heart', and to have headaches and neuralgias. They depend upon tea to take the place of food, and soon use up what little force they have without replenishing with new fuel-food. The caffeine of coffee increases heart action and may be used to advantage in cardiac debility, but coffee should be taken in moderation where cardiac action is already too vigorous. Vogel has advised the use of strong coffee with cream as a tonic and food in debility accompanying the acute diseases of children.

Alcohol. Liebig says "Alcohol stands only second to fat as a respiratory material," but adds that "the same effect could be produced in the body by means of saccharine and farinaceous articles of food at one-fourth or one-fifth the cost." Fothergill also holds "that the chief portion of the alcohol injected undergoes consumption in the body," but insists that "the question of 'alcohol as a food' can never be separated or divorced from that of 'alcohol as a stimulant', as a force-liberator. Again, Liebig wrote that "the use of spirits is not the cause but the effect of poverty. It is the exception to the rule when the well-fed man becomes a spirit-drinker. On the other hand, when the laborer earns by his work less than is required to provide the amount of food which is indispensable in order to restore fully his working power, an unyielding, inexorable law or necessity compels him to have recourse to spirits. He must work; but in consequence of insufficient food, a certain portion of his working power is daily wasting. Spirits by their action on the nerves, enable him to make up the deficient power at the expense of his body; to consume to-day that quantity which naturally ought to have been employed a day later." This may also be the case where there is an abundance of food, but where it is improperly chosen for the needs of the individual or ruined in the preparation by bad cookery. The principles of the scientific and economical selection of food and its preparation may thus become a means of preventing those diseases that depend on or are aggravated by insufficient or improper food, and consequent alcoholic excesses. The effect of alcohol upon the weak and savage races is much more marked and disastrous than upon the civilized and strong; so it harms the health of the underfed and overworked much more than it does that of the well-fed man of means and leisure; and women and children more than adult men. This latter point is to be remembered in practice. Remember also that while alcohol is partially a respiratory stimulant, it is a force-liberator and consumes the body-store, and unless given with other readily oxidizable food, you run the risk of putting your patient "in a grave never dug by Nature," especially where there is danger of the patient sinking from exhaustion. But it is just in these cases when given with other food that we find alcohol a most valuable therapeutic agent. Give with it foods that produce heat and force, some form of the soluble carbo-hydrates, as maltose, malt extracts, milk, milk whey or even soluble sugar.

Where the assimilative powers are weak it may be advantageous or necessary to partially or wholly predigest these foods. But above all remember to replace what alcohol takes from the body store or'physiological bankruptcy'will ensue. Also,that though alcohol may be a food,in a sense,it is a very costly one,and that intoxication would occur long before a man could get the equivalent of a full meal. Practically,in sickness alcohol is to be used to sustain the powers,to meet emergencies,to lift the patient over obstructions in the road to health;and such use requires a thorough knowledge of its action coupled with the highest judgment. In malt liquors there is considerable maltose left unchanged, thus giving with the alcohol a soluble carbo-hydrate of the highest value;and these may often be used with benefit as tonics,especially where convalescence is prolonged. FOthergill gives two first class rules for the use of alcohol by the healthy:-Never have alcohol in the brain when it.has work to do. A little alcohol betwixt a man and past trouble is permissible;but it is not well to put a little alcohol in front of a coming trouble" Murchison,in his work on Fevers,lays down these rules for practice which it would be well for all to adopt:-"What then are the conditions of the animal economy in which alcohol may be of positive use? That there are such conditions I believe cannot be denied by any one who has honestly studied the subject;but they are not the conditions of perfect health. It is especially when the circulation is weak or sluggish, that a daily allowance of alcohol may do good.Thus:-1. Alcohol is useful in the course of most acute diseases,when the organs of circulation begin to fail,as they are apt to do. A moderate quantity usually suffices. The large quantity still sometimes administered may do harm by inducing congestion of internal organs. 2. In convalescence from acute diseases, or from other weakening ailments,when the circulation remains feeble and the temperature is often sub-normal,alcohol is useful in promoting the circulation and assisting the digestion. 3. In persons of advanced life the circulation is also often feeble,and a moderate allowance of alcohol often appears to be beneficial. All other conditions of the system marked by weakness of the muscular wall of the heart,whether permanent or transient,are usually benefitted by alcohol.""Alcohol is a good servant but a bad master." King Chambers says:-Let alcohol be taken never as a stimulant or preparative for work,but as a defence against injury done by work,whether of mind or body.For example,it is best taken with the evening meal,or after toil. Let the increase in the desire for and power of digesting fodd be the guide and limit to the consumption of all alcoholic liquids. Let the forms be such as contain the least proportion of fusel oil. Let all with an hereditary tendency to hysteria or other functional diseases of the nervous system,refrain from its use altogether,even though as yet in good health."